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Harry's Hard Choices: Mine Refuge Chamber Training

Instructor's Guide

Department of Health and Human Services
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NIOSH

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Mine Refuge Chamber Training

Instructor's Guide

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Centers for Disease Control and Prevention
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ACRONYMS AND ABBREVIATIONS USED IN THIS REPORT

CO	carbon monoxide
CO_2	carbon dioxide
NIOSH	National Institute for Occupational Safety and Health
SCSR	self-contained self-rescuer

UNIT OF MEASURE ABBREVIATIONS USED IN THIS REPORT

ft	foot
ppm	part per million

HARRY'S HARD CHOICES:

MINE REFUGE CHAMBER TRAINING

INSTRUCTOR'S GUIDE

Content

This paper-and-pencil simulation is an interactive story that presents a scenario in which Harry Hamilton, a section foreman on a longwall setup section, must decide what to do when he learns there is a fire in his mine. As time goes along, Harry must face a series of choices about how best to increase his and his crew's chances for survival. The story is taken in part from real-life incidents.

Objectives

The completion of this exercise can help new miners, experienced miners, trainers, and others who must deal with issues of self-rescue and escape become more aware of:

- The need to gather as much information as possible as early as possible
- The value of knowing one's escapeways
- The need to use self-contained self-rescuers (SCSRs) properly
- The value of a multigas detector in an emergency
- When, and under what circumstances, to enter a refuge alternative

Intended Audiences

- Miners in annual refresher classes
- Trainers
- Responsible Persons
- Command center personnel
- Original equipment manufacturers
- Researchers

How to Present These Materials to Trainees

- Inform trainees that the mine in the exercise may not be laid out like their own mine. Discuss the layout with the class; highlight specific differences.
- Define any terms the trainees might not be familiar with (such as "Responsible Person").
- Have them read through the exercise problem booklet and mark each statement: "YES" for agree or "NO" for disagree.
- After the trainees have completed the problem booklet, they should look at the explanations provided in the answer key. **Ask them not to look at the answer key before they complete the exercise**.
- Use the materials in one of the following ways:
    - During annual refresher training to introduce the notion of refuge chambers and in-place shelters.
    - On the section as part of the escape drill scenario.

Materials Needed [1]

- "Harry's Hard Choices" Problem Booklet (one copy for each person)
- Answer key for "Harry's Hard Choices" exercise (one copy for each person)
- "Harry's Hard Choices" Instructor's Guide with answer key included (one copy for each trainer)

Discussion Questions and Teaching Points

There are two major points that this simulation is meant to teach trainees: (1) self-rescue is always the best option unless all means of egress are blocked – the presence of smoke should not deter escape; and (2) in addition to providing refuge for individuals awaiting rescue, there may be valid uses of rescue chambers as aids in escapes.

Since self-rescue largely depends on the effective use of SCSRs, the "Harry" problem deals in some depth with the use and misuse of these devices. Researchers with the National Institute for Occupational Safety and Health (NIOSH) have determined, through extensive interviews with workers who have escaped underground mine fires, that individuals tend to "cheat" by breathing around their mouthpiece and often take their mouthpiece out to talk. This is reflected in the story and will provide you the opportunity to stress, from a somewhat different perspective, the danger of taking a mouthpiece out.

There have been instances in which individuals were convinced their apparatus was not working. While this is undoubtedly true in some cases, there is also the possibility that the miner simply did not know what to expect when he or she donned the device. NIOSH has therefore identified a series of SCSR characteristics that potential users should be aware of [Kowalski-Trakofler et al. 2008]. You may want to discuss these in your classes, or distribute them as handouts:

Starting the unit: Miners must start all types of units either by pulling a cord or opening a valve. Chemical-oxygen SCSRs may be cold-started by exhaling into the unit until the bag is full.

All units get hot: Units get hot, so the miner may experience discomfort on his/her chest. It was suggested that miners use their clothing, a glove, or even an empty rock dust bag to put between their chest and the unit.

Units may induce a cough: Most units are packed with a dustlike substance (talc/cornstarch) to prevent the hoses from sticking together or to absorb saliva. Coughing may last a few minutes. Miners are advised not to remove the mouthpiece and to cough into the unit. Subjects also suggested that use of a mouthpiece may produce a gag reflex.

Some units may have a taste: Miners have reported a variety of different tastes, from no taste to a rubbery or bitter or metallic or salty taste. A cornstarch taste was noted most frequently.

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[1] Adapted from "No Way to Meet a Neighbor," a paper-and-pencil simulation developed by Henry P. Cole, Ed.D., et al. at the University of Florida's Biological and Agricultural Engineering Department (September 1997).

Resistance to breathing: Chemical-oxygen units may be difficult to breathe through. The resistance increases with time, causing breathing to become even more difficult. Under normal circumstances, the unit will continue to work as resistance builds up. Some miners have described breathing through the units like breathing through a straw.

The air breathed: In chemical-oxygen units, the air is generally hot and dry. It may take a while for the chemical reaction to start. The harder the miner breathes, the greater the chemical reaction. Some subjects reported that their throat and tongue got dry, making it difficult to swallow. Compressed oxygen units were found to be hot and very humid.

Nose clips: Nose clips are usually reported to be uncomfortable, and it takes some time getting used to breathing through the mouth. Mouth breathing may cause drool to accumulate around the mouth.

Goggles: Goggles protect the eyes from smoke and toxic gases. Subjects reported that goggles fog up or can fill with sweat, which can be uncomfortable and decrease visibility.

The bag: The bags on different units behave differently. It is important for miners to know about the specific unit they are using to understand how the bag functions.

Your trainees may be unfamiliar with refuge alternatives and some of the issues involved in a prolonged stay in one. Here are some possible physiological and psychological issues you might want to discuss in your classes:

Physiological: Heat stress from high temperature and humidity, cardiovascular system stress, deep-vein thrombosis leading to pulmonary embolism from inactivity, pulmonary function stress from increased carbon dioxide (CO_2), muscular problems from inactivity, and skin problems from sitting stationary for a long period of time.

Psychological: Feelings of claustrophobia, anxiety, panic, or depression; aggressive feelings due to prolonged confinement; adverse feelings due to complete loss of privacy or loss of control of the situation; reduced cognitive skills such as judgment; and long-term psychological effects from the chamber experience (posttraumatic stress disorder).

Ideas, Notes, and Comments

Use this space to write down your ideas and plans for using these materials.

INSTRUCTOR'S PROBLEM BOOKLET AND ANSWER KEY

HARRY'S HARD CHOICES

This is a story about Harry Hamilton, a section foreman on a longwall setup section, who must decide what to do when he learns there is a fire in his mine. As time goes along, Harry must face a series of choices about how best to increase his and his crew's chances for survival. The story is taken in part from real-life incidents.

Instructions

Get together with two or three of your coworkers. Then read the story and address the statements that appear in the story.

After you have decided whether or not you agree with each statement, discuss them with the people working with you. Then continue reading the story and address and discuss the statements.

It is important to note that Harry may not always take the actions that you would take. You should nevertheless continue the story to the end. The answer key gives the reasons why a particular choice is considered a good one or not.

When you finish the story, look at the copy of the **answer key.** Compare your answers to the answer key, but don't change your answers. Discuss the story and answers with the class and your instructor. Give the booklet with your answers to the instructor. Your answers will provide feedback to be used to improve the teaching points and the clarity of future presentations.

Thanks, and enjoy working through the problem.

Harry Hamilton is the section foreman on a longwall setup section. He is 37 years old and is in good physical condition. He has been a community volunteer fireman for more than 15 years. Before taking a management position, he was a fire boss for 5 years. He knows the mine well. There are eight persons, besides Harry, working on this section. Five of them are under age 40, and three are over 50.

Here are some characteristics of the mine:

REFUGE ALTERNATIVES:

- REFUGE CHAMBER: Inflatable chamber that can hold 16 people, provides them with 96 hours of oxygen, and uses a scrubber system to maintain CO_2 levels below 5,000 ppm. The chamber has just been moved; it is located three crosscuts from the face.
- IN-PLACE SHELTERS: These can hold 16 people, provide them with 96 hours of oxygen, and use lithium hydroxide curtains to maintain CO_2 levels below 5,000 ppm. They are located at every other SCSR cache (every 8,800 ft).

During training, the miners have been told that refuge alternatives are to be used only as a last resort—when escape is **absolutely** not possible.

MINE LAYOUT:

- The coal seam is 54 inches, but top has been taken in the track entry to allow movement of supplies and equipment.
- This is a longwall development section that has been driven 10,000 ft from the mains.
- The 60-inch belt is located in #1 entry. Belt air moves inby from the dumping point at the mouth of the section to the tailpiece.
- Crosscuts are on 100-ft centers.
- The primary escapeway is the #3 entry, the main intake. The alternate escapeway is the #2 track entry.

RESOURCES:

- Each miner wears a chemical-oxygen SCSR on his/her belt. There are 10 SCSRs stored at the power center and 12 on the portal bus.
- Harry has a handheld multigas detector that detects methane, oxygen, and carbon monoxide (CO).
- A 25-ft tether is kept at the SCSR cache at the power center.
- The mine uses trolley haulage for moving supplies and personnel.
- The mine uses a carbon monoxide monitoring system ("CO monitor").
- Communications are by pager phones, trolley phones, and leaky feeder. The latter is a system with mobile radio transceivers that allow personnel to communicate with each other underground.
- At this mine, man doors are located at every fifth crosscut when possible.

Problem

Harry and Bill, the utility man, are checking materials at the supply car. At 10:15 a.m., Clem, one of the buggy men, hustles up to Harry and says, "The alarm went off. It looks like smoke is coming up the belt." Harry replies, "Go get the crew and bring them to the power center while I call the CO Room."

The operator confirms the CO monitor has alarmed along the 3 Northeast main belt. They have sent someone to check it out. Harry says, "We've got smoke. We're coming out."

Look at Tables 1 and 2 and Figure 1 below.

Then turn to **Question A** and begin.

Work one page at a time.

Don't jump ahead, but you can look back anytime you want.

Table 1.—Miners who have key roles in the story

Name	Occupation	Age	Years worked in mine	Physical condition
Harry	Section foreman	37	10	Good physical condition
Bill	Utility man	23	2	Good physical condition
Clem	Buggy man	56	38	Poor physical condition, heart problems
Charlie	Bolter operator	39	15	Mediocre physical condition

Table 2.—Other miners on the crew

Name	Occupation	Age	Years worked in mine	Physical condition
Joe	Miner operator	51	18	Diabetic
Larry	Mechanic	38	5	Mediocre physical condition
Dave	Buggy man	28	7	Good physical condition
Susan	Miner helper	40	15	Good physical condition
Tom	Bolter operator	62	44	Poor physical condition, experiences shortness of breath

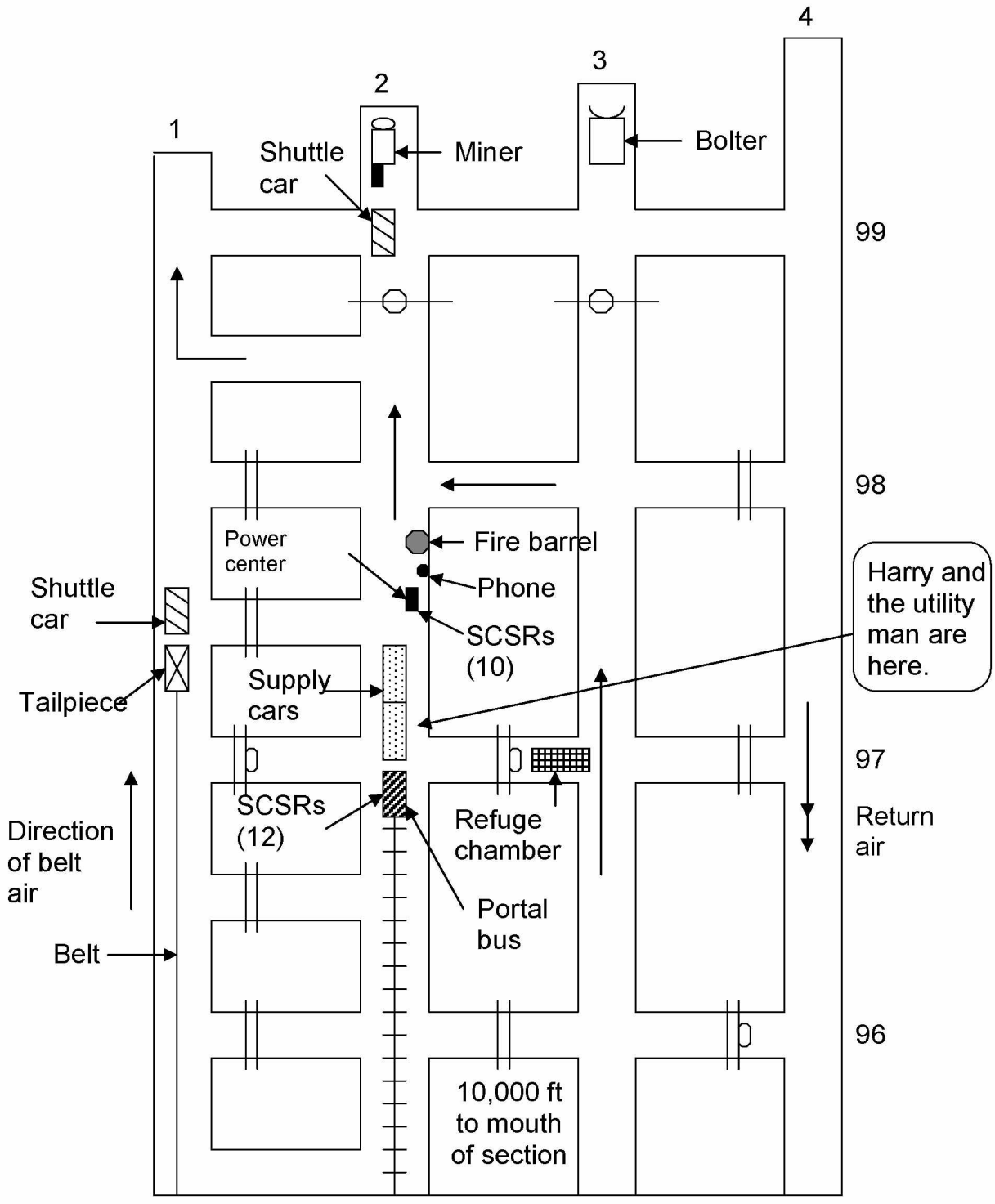

Figure 1.—Schematic of the mine working section.

Question A

While Harry is talking to the CO Room, he sees light smoke coming up the track entry. He sends Bill to check #3 entry, the primary escapeway, and heads to the power center. Harry tells everyone to take an SCSR from the cache. Bill comes back from checking #3 entry and reports that it is "pretty clear."

The smoke is getting heavier in the track entry and is beginning to smell like coal. Visibility is still fairly good—about 100 ft. It is time to move. What actions should Harry take at this point? (Read each statement. Select YES if you agree with the statement or NO if you disagree.)

	Correct answer is in **BOLD**:		Statement:	Answer Key:
1.	**YES**	NO	Make a note of the time.	Harry will need to know how long the crew members have had their SCSRs on since they supply only about an hour of oxygen.
2.	YES	**NO**	Lead the crew to the refuge chamber and prepare to activate it.	The problem with having a refuge chamber so close to the face is that Harry must decide almost immediately whether to enter it or not. At this time, there is little information available. There are no indications that Harry will not be able to evacuate the mine. At this point, they should evacuate.
3.	**YES**	NO	Tell the CO Room the crew will be coming out on the portal bus.	There is some debate whether a portal bus should be operated in a fire because of the possibility of an explosion. Generally, however, it is thought best to ride through smoke as far as possible because there will be less strain on the miners, who will be stressed as it is. Harry has a multigas detector with which he can check for methane.
4.	YES	**NO**	Wait another 10 minutes to see if they can get more information on where the fire is before they head out.	In a mine fire, time is not your friend because mine fires double in size every 15 minutes. In addition, the miners are likely to be under stress and want to take action now. It is best to ask for information when possible on the way out.
5.	**YES**	NO	Tell the crew to grab the tether, don an SCSR, and check each other to make sure the devices are working correctly.	Even if there is little CO present at this point, it can build up quickly when there is little or no smoke. Harry has a multigas detector so he will know when CO starts to build up, but the miners should still keep their SCSRs on. Regarding checking each other out when donning the SCSRs, it is known that some people have problems in getting them on properly and can use help. It is also known that some individuals think their apparatus is malfunctioning when it is working properly. Donning the device correctly may give an individual confidence that the SCSR is working correctly.
6.	YES	**NO**	Lead the crew to the portal bus to get a spare SCSR, and prepare to walk out the primary escapeway.	It is probably better to ride as far as possible because, among other things, breathing from an SCSR is a real problem for some people. Better to let them be at ease as long as possible. In addition, the primary escapeway is only 54 inches high. It would tire the crew out, especially if they have SCSRs on. For the time being, the better option is to ride out.
7.	**YES**	NO	Check the CO level in the track entry.	Harry should make CO checks as often as possible.

Question B

The crew members have donned their SCSRs and assembled by the portal bus. Harry instructs the crew to grab a spare SCSR. He then checks the CO level. It is only 35 ppm. At 10:30 a.m., the crew heads out on the bus. Harry tells the operator not to travel too fast. The smoke is getting thicker; visibility is poor.

The crew travels outby for 10 crosscuts when the bus hits a low rail joint in a soft spot in the bottom. The bus travels across the spot where the rail dips and derails. As the crew members are climbing off the bus to assess the situation, Charlie, one of the bolter operators, steps on a piece of coal and twists an ankle. He says to Harry, "I don't know that I can walk out. Maybe we should go back to the refuge chamber." What should Harry do at this point? (Read each statement. Select YES if you agree with the statement or NO if you disagree.)

	Correct answer is in **BOLD**:		Statement:	Answer Key:
8.	YES	**NO**	Walk inby three crosscuts where the man door is located and check the air in the primary escapeway (#3 entry) for smoke. If the visibility is better, signal the crew to follow him.	Harry needs to check the primary escapeway, but the crew would probably feel better if he went ahead rather than getting behind them. Harry is the leader, so he should keep himself in a position to lead.
9.	YES	**NO**	Get the tether, fasten it to each crew member, and head out the track entry following the lifeline.	It is much more difficult to walk through smoke, so if there is little or no smoke in the primary escapeway, Harry should take that route. It won't be an easy decision, however, because he will have to make a tradeoff between having his crew possibly panicking in smoke or walking stooped over while wearing SCSRs.
10.	**YES**	NO	Take a deep breath on his SCSR, remove the mouthpiece, and call the CO Room on the trolley phone to report the crew's location, the smoke, inform her of the route they are walking out because the bus has derailed, and ask for information on the fire.	Mine rescue rules require that an atmosphere containing more than 50 ppm of CO be treated as irrespirable. At 35 ppm Harry may talk, but he runs the risk of inhaling some smoke with other contaminants that a multigas detector might not detect. Harry really needs to communicate with the outside, however, so it's a tradeoff.
11.	YES	**NO**	With Charlie injured and over 7,000 ft to walk just to get to the in-place shelter, it is now time to go back to the refuge chamber.	This is a hard choice. The idea of self-rescue, however, means that you should get yourself out of the mine. Harry has seven other people to think about. He does not, at this time, have any information to make him believe the escapeways are impassible.
12.	YES	**NO**	Tell Charlie to go to the refuge chamber and continue to evacuate out the track entry with the crew.	There is a possibility that Charlie might not know how to activate the chamber or might not be able to for some other reason. If he can walk, he should stay with the crew. Besides, evacuation is always the first choice.
13.	**YES**	NO	Walk outby to the next man door to check the air in the primary escapeway (#3 entry) for smoke. If the visibility is better, signal the crew to follow him.	Harry needs to stay ahead of the crew. In fact, he may decide to take them with him to the next man door rather than leave them at the portal bus.
14.	**YES**	NO	Signal Charlie and the rest of the crew to keep their mouthpieces in.	Even if it seems absolutely necessary for Harry to have limited communication, there is no reason for anyone else to take his/her mouthpiece out. Besides, Harry is the only one with a multigas detector.
15.	YES	**NO**	Jack the portal bus back on the track and keep going.	If the bottom is soft, it probably wouldn't support the jack unless a cap board or something similar could be found to provide a larger base. That would take time and might be a futile effort. There is also the problem of smoke. Since much smoke would be stressful, the crew would want to get out of it if possible.

Question C

Harry walks a couple crosscuts outby and checks #3 entry. Visibility is much better; there is very little smoke. Using his multigas detector, Harry finds the CO level is only 15 ppm. Even though the seam height is just 54 inches, Harry has the crew tether themselves together. Charlie doesn't want to go into the refuge chamber by himself, so he decides to limp along with the others. Harry starts to lead the crew out the primary escapeway.

Harry sets a moderate and steady pace so that he and the crew don't "outbreathe" their SCSRs. Even so, some of the miners' breathing is labored. Harry checks his watch and notes that the crew has been under apparatus for about 10 minutes. He wonders how much longer the crew will hold up walking hunched over. Nevertheless, Harry stays in the primary because the visibility is good and the CO level is low (15–20 ppm). Almost all at once, however, the smoke starts to get dense, and Harry signals the crew to grab the lifeline. It is not too much farther to the SCSR cache.

Fifteen minutes later, Harry's hand encounters a bell that has been suspended from the lifeline. This tells him he has reached the SCSR cache. He stops to collect his thoughts and checks the time. It is now 11:02 a.m., and the miners have been wearing their SCSRs for over 40 minutes. He checks the CO level; it is only 40 ppm. What should Harry do at this point? (Read each statement. Select YES if you agree with the statement or NO if you disagree.)

Correct answer is in **BOLD**:			Statement:	Answer Key:
16.	YES	**NO**	Switch over SCSRs and lead the crew back to the refuge chamber because Harry does not know how far they will have to travel to reach fresh air.	Harry is halfway between the refuge chamber and the in-place shelter. Therefore, he should continue forward with the crew to the in-place shelter so they will be closer to the portal for the rescue teams to find them.
17.	**YES**	NO	Switch over SCSRs here where there are spares available in case somebody gets one that he/she thinks isn't working.	It is a good idea to switch over SCSRs here where there are spares available in case somebody gets one that he/she thinks isn't working. By switching SCSRs out here, the crew is also maximizing their amount of oxygen time between here and the next SCSR cache (i.e., between the SCSR they are wearing and the one they are carrying, they now have 120 minutes. If they didn't switch over here, they would only have about 90 minutes of oxygen).
18.	YES	**NO**	Have each miner grab another SCSR so they have two spares, and hold off on the switchover so there will be plenty of time to reach the in-place shelter before the crew has to switch again.	Although Harry might want each miner to take a spare, he should go ahead and switch over the SCSRs at the cache because that would maximize their amount of oxygen.
19.	YES	**NO**	Proceed to the in-place shelter before switching over, since it is only another 20 minutes and SCSRs are designed to provide an hour's supply of oxygen.	Even though they have 20 minutes left on the SCSR, the breathing resistance is building up and the more resistance, the harder it is to breathe. Switching over now also gives them added oxygen time in case it takes longer than anticipated to reach the in-place shelter.
20.	**YES**	NO	Untether and go to the man door and check the CO level in the track entry. If it is also low there, get the crew and switch over to the track entry.	Harry untethers so as not to stress the crew by dragging them with him every time he makes a move. Since the man door is straight behind the cache, Harry will be able to keep his hand on the rib, minimizing his risk of getting disoriented. If the CO level is low in the track entry, then the conditions are comparable in both entries. However, the track entry's top has been taken out, so the crew can walk upright instead of hunched over. Harry would want to switch over from the primary entry to the track entry.

Question **D**

As the crew goes through the switchover procedure, some of them seem confused, some are talking, and most have taken one or two breaths before they manage to get their lungs isolated. With Harry's help, the miners finally get their SCSRs swapped out, but not before several of them have inhaled some smoke and CO.

Harry checks the CO level. There is little difference in the two entries: 40 in the primary and 45 in the track. Harry decides to lead the crew across to the track entry so they can walk upright and pick up the pace. They aim for the next cache, with everyone holding onto the lifeline. They go as fast as practical for 38 more crosscuts. Then Charlie says, "I can't keep up with you, my ankle is swelling up!" At that point, Clem spits his mouthpiece out and says, "I can't go any farther. You guys just leave me and go on." Harry has been counting the crosscuts; he knows the in-place shelter is just a little farther. What should Harry do now? (Read each statement. Select YES if you agree with the statement or NO if you disagree.)

	Correct answer is in **BOLD**:		Statement:	Answer Key:
21.	**YES**	NO	Go back to Clem and Charlie and try to get them to reinsert their mouthpiece.	Harry would want them to reinsert their mouthpiece for two reasons: (1) they never know when the CO is going to build up, as it can rise quickly; and (2) they can be overcome with smoke inhalation even when CO levels are low. Besides, Harry is the only one with a multigas detector.
22.	YES	**NO**	He should leave Clem and Charlie.	When evacuating in mine emergencies, miners are trained to self-rescue. However, in this situation they are so close to the in-place shelter that they should assist the two miners in trouble. Also, it does not increase the risk of danger for the rest of the crew.
23.	**YES**	NO	Motion for volunteers to help Clem and Charlie get as far as the in-place shelter.	By assisting the two miners to the in-place shelter it does not increase the risk of danger for the fellow crew members very much, but it dramatically increases the probability of survival for the two.
24.	YES	**NO**	Since Harry does not know where the fire is and the smoke is so thick, he should lead his crew back to the refuge chamber.	Smoke should not impede the evacuation, since they have adequate sources of oxygen. They should continue to evacuate until they are in fresh air.

Question **E**

Harry, with the help of other crew members, assists Clem and Charlie toward the in-place shelter. The miners have been wearing their SCSRs for 40–45 minutes. Harry checks for CO in the crosscut near the chamber. CO is building up. His multigas detector reads 280 ppm.

The miners activate and enter the in-place shelter and Harry calls outside. The CO Room tells him the fire is at the head drive in 3 Northwest mains, and it is not yet under control. Harry knows the crew will have to travel another 55 crosscuts through smoke to get outby the fire. What does he do now? (Read each statement. Select YES if you agree with the statement or NO if you disagree.)

Correct answer is in **BOLD**:			Statement:	Answer Key:
25.	YES	**NO**	Ask the crew what they prefer to do at this point: stay in the in-place shelter or continue to walk out.	Evacuation training teaches them to walk out. Since six of the miners are able-bodied, they can still walk out. Harry should not bring up the option of staying in the in-place shelter.
26.	**YES**	NO	Remind everyone that he was a fire boss, knows the mine well, and that they will be walking through smoke, but he can lead them past the fire.	As leader of the group, Harry should remind the crew of his knowledge of the layout of the mine and remind them of their goal: to get out of the mine.
27.	YES	**NO**	Tell the crew that the best option is to remain inside the in-place shelter until a mine rescue team can reach them.	For the miners able to travel, a decision to stay in the in-place shelter based on the notion that a rescue team can reach them is probably not the best decision. Mine rescue teams may not be allowed into the mine until the fire is under control. There is no guarantee that they will be able to get the fire under control.
28.	**YES**	NO	Check on Clem and Charlie's condition and ask them if they can manage to walk the rest of the way out.	Harry should make every effort to encourage both Clem and Charlie to evacuate the mine. If they absolutely refuse, then Harry has no choice but to lead the rest of the crew out.
29.	**YES**	NO	Tell everyone before they leave the in-place shelter that it is time to switch over their SCSRs, and lead them through the procedure.	Since they are in the activated in-place shelter with oxygen flowing, they should take the time to switch over their SCSRs there. They only had 15 minutes left on their previous SCSRs anyway.
30.	**YES**	NO	Ask the crew members if they want to rest for a few minutes before they don fresh SCSRs and then walk the rest of the way out.	Since they have over a mile to walk out in unknown conditions, they should take a few minutes to rest up. However, in a fire time is not your friend. So every minute the crew is sitting there, the fire continues to burn. Keep in mind that the mine rescue team may not be allowed to enter the mine until the fire is under control.
31.	**YES**	NO	Encourage anyone who might want to stay in the in-place shelter to attempt to walk out.	Harry should make every effort to encourage the miners to continue to evacuate.

***Question* F**

Charlie says his ankle is in too bad a condition to go farther; he'll just wait for the rescue team. Clem says he is in no shape to continue and decides to stay with Charlie. Everyone else is anxious to get going. Harry tells the crew members they must travel 12 more crosscuts to the mains and another 43 crosscuts to make it outby the fire. He states that they won't need to do anymore switchovers; it should take only somewhere between 30 and 45 minutes to get out.

Harry leads the crew out the track entry to the mains holding onto the lifeline and walking until they are outby the fire. There, they see the shift foreman and some other miners. There is a portal bus waiting to take them outside.

At 1:15 p.m., the crew arrives outside, two crew members are transported to a local hospital for smoke inhalation. Everyone else is all right except for being exhausted.

The Responsible Person is busy establishing a command center. He tells Harry that no mine rescue teams will be sent underground because the fire is still not under control. The Responsible Person has contacted Clem and Charlie and advised them to remain in the in-place shelter until the fire is brought under control, which he estimates will take several hours. Both men are afraid that the mine rescue teams won't be able to come into the mine at all. They begin discussing trying to make it out now that they know the rescue teams are, at the very least, not coming right away. They are nevertheless advised by the Responsible Person to stay put. What should they do? (Read each statement. Select YES if you agree with the statement or NO if you disagree.)

Correct answer is in **BOLD**:		Statement:	Answer Key:
32.	**YES** NO	Stay put.	This is probably the toughest decision, and one Harry is glad he doesn't have to make. However, there are several things to consider: (1) Both Clem and Charlie are in pretty bad shape or they wouldn't have been left behind in the first place. (2) Conditions are deteriorating, and if getting out was difficult in the first place, it is even more difficult now. (3) The Responsible Person is supposed to know what he is talking about. If he says the fire can be brought under control in a few hours, there should be reason to believe him. (4) If Clem and Charlie leave the in-place shelter, the mine rescue team won't know where to look for them should they get down again. These points must be weighed against their fear that the mine rescue team won't be coming for them. In the end, it boils down to where they place the most faith—in the mine rescue team's ability to come get them or in their ability to make it out on their own. Given the odds against them, they should probably remain in the in-place shelter as instructed and wait for the mine rescue team. This is certainly an issue that can, and should, be debated.
33.	YES **NO**	Leave.	An in-place shelter has two potential uses: (1) as a way station where miners can rest, regroup, get additional SCSRs, and communicate with the surface, and (2) as a refuge of last resort to await rescue. Harry has used the in-place shelter for both purposes. Given that Clem and Charlie have problems that might very well keep them from escaping the mine, they could stand a better chance if they remain in the in-place shelter, placing their faith in the Responsible Person's assurance that the fire can be brought under control. Again, this is a debatable issue.

In Hindsight

Given the circumstances, Harry may be tempted to second-guess himself. After all, even though he got six miners and himself to safety, he left two men to an uncertain fate. Beginning with Harry's decision to start walking out after derailing instead of returning to the section and entering the refuge chamber, which decisions might you have made differently than Harry (if any) and why? Below are a few of the issues debated by trainees who have worked this problem and points they considered—both pro and con:

- The question of whether Harry should have taken out his mouthpiece to communicate with the outside. Points to consider:

  Pro

  - Met need to talk to CO Room
  - CO well below 50 ppm

  Con

  - Danger of smoke inhalation
  - Might set a bad example

- Riding out versus walking out – There was some debate whether a portal bus should be operated in a fire. Points to consider:

  Pro

  - Fastest way out of the mine
  - Less stress on miners

  Con

  - Risk of explosion
  - Risk of crashing

- Whether to continue out the track entry after derailing. Points to consider:

  Pro

  - Can stand up in the track entry
  - Saves time

  Con

  - Track is in heavy smoke
  - Travelway might be rough

- Switch over SCSRs at the cache instead of depleting one's SCSR to reach the in-place shelter. Points to consider:

  Pro

  - Avoids breathing resistance problem

  Con

  - The problem of changing out in smoke

- Harry did not ask the crew's opinion on staying in the in-place shelter. Points to consider:

  Pro

  - The plus side of not asking (for those who argued that Harry did the right thing) is that he kept the crew focused on escaping. These trainees believed that Harry should not plant the idea of staying in crew members' heads.

  Con

  - A sizable number of trainees believed that Harry was wrong in not asking the crew if they wanted to stay in the in-place shelter. They based their argument on the fact that ultimately it's up to each person to decide his or her own fate.

REFERENCE

Kowalski-Trakofler KM, Vaught C, Brnich MJ Jr. [2008]. Expectations training for miners using self-contained self-rescuers in escapes from underground coal mines. J Occup Environ Hyg *5*(10):671–677.

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