

Escape From A Mine Fire

Instructor's Copy

Behavioral Research Aspects of Safety
and Health Group (BRASH)
Institute for Mining and Minerals Research (IMMR)
University of Kentucky, Lexington, Kentucky¹

Mining Systems and Human Engineering
U. S. Bureau of Mines
Pittsburgh, Pennsylvania

¹ This exercise was developed and field tested under U. S. Bureau of Mines research contract no. H0348040. The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies or recommendations of the Interior Department's Bureau of Mines or the U. S. Government.

Contents

| | |
|--|----|
| Introduction | 3 |
| Exercise summary | 3 |
| How to use this exercise | 4 |
| Performance objectives | 5 |
| Master answer sheet | 6 |
| Instructor's discussion notes | 11 |
| References | 21 |
| Scoring Key | 22 |
| Appendices | |
| Appendix A: Problem booklet (duplicate this copy for use in class) | |
| Appendix B: Answer sheet blanks (print the answers on these blanks) | |
| Appendix C: Invisible ink answers (print these on the answer sheet blanks) | |

Introduction

This document contains most of the materials needed to use the exercise. The main part of the document is the instructor's copy. It tells how to use the exercise, presents the objectives, the master answer sheet, the scoring key, and, discussion notes to be used following the exercise. The last part of this document is three appendices. Appendix A is the exercise problem booklet. This booklet can be duplicated locally. The booklets are reusable. One is needed for every person in the classroom. Appendix B is the answer sheet. Copies of this answer sheet must have the invisible ink answers that appear in Appendix C printed on them.² Answer sheets are consumable. One is needed for each small group of 3 to 5 persons who work the exercise.

Exercise Summary

Read this section first. It determines if the exercise is appropriate for your classes. If you choose to use the exercise, examine the table of contents and review the remainder of this document.

| | |
|------------------|--|
| <u>Type:</u> | Invisible ink |
| <u>Audience:</u> | Underground coal miners |
| <u>Length:</u> | Fourteen questions (40 minutes for administration plus 40 for discussion) |
| <u>Skills:</u> | Escape strategies and procedures including choice of routes, use of emergency breathing apparatus, information gathering, and communication Ordering priorities and making life and death decisions when faced with a hostile environment and insufficient means and times for all miners to escape from a section |
| <u>Location:</u> | Underground coal mine section, 48 inch seam height |
| <u>Problem:</u> | You are the section foreman on a 3 entry longwall development panel 2,500 feet from the mains, and 15,000 feet from the nearest portal. You are in the belt entry 7 crosscuts outby the face when you see smoke coming up the belt. As you warn and assemble your crew the smoke becomes thick. A call from the surface reports a fire and orders your immediate evacuation of the section. You don't know where the fire is. You lead the miners out the intake air entry only to encounter heavy smoke after a few crosscuts. You direct your crew to don their SCSRs and continue on. Soon one miner cannot keep up and delays the escape of the other miners. You still may have over two miles to travel in smoke so thick that you can see only a few inches. You must decide what to do to help your crew escape from the mine before their SCSRs are depleted. But you also do not want to leave the one miner behind. |

² You can do this yourself if you have the proper equipment, or you may obtain copies of preprinted answer sheets from MSHA, National Mine Health & Safety Academy, Dept. of Instructional Materials, 1301 Airport Road, Beaver, WV 25813-9426 phone 304-256-3257, fax 304-256-3368 or email to lord-mary@msha.gov.

How to Use This Exercise

1. Look at the performance objectives. Decide if the exercise is relevant for your mine training class.
2. Work through the exercise with the developing pen and score your responses.
3. Read the master answer sheet for the exercise. Look at all the answers.
4. Read the "Instructor's Discussion Notes" for the exercise.
5. Become thoroughly familiar with the problem so that you can present it to your class without reading it. Put the figures on an overhead projector so you can use these to help explain the problem.
6. When you present the exercise to the class:
 - Give each person a problem booklet, and each group of 3 to 5 persons an answer sheet and a developing pen.
 - Demonstrate how to select and mark answers using the developing pen.
 - Go over the instructions for working the exercise with the whole group.
 - Explain the problem making sure everyone understands the problem situation.
 - Have the class members work the exercise.
 - When the class members finish, have them figure up their score using the instructions at the end of the exercise.
 - When everyone has finished, discuss the exercise. Let class members discuss the merits of each answer. Add your own ideas.

Performance Objectives for the Escape From A Mine Fire

| Objective number | Capability verb(s) | Description of required performance and conditions under which it is to occur |
|-----------------------|------------------------------|---|
| 1. EE/SR ³ | Recognize Comprehend | The lifesaving value to section crews of accurate and prompt communication by surface personnel concerning the location and size of a mine fire |
| 2. EE/SR | Recognize Recall | The purpose and utility of designated assembly points for points for evacuation of mine sections during emergencies |
| 3. EE/SR | Anticipate Predict | The probable rate and direction of smoke movement through a mine section given a mine map with ventilation arrangements and air velocity values |
| 4. EE/SR | Select Evaluate Adjust | Escape strategies and routes from a mine given a mine section map, information about conditions on the section, and little information about the source and location of smoke on the section |
| 5. EE/MG | Recall Apply | Basic information and facts about the toxic effects of carbon monoxide, oxygen deficiency, the capabilities and limitations of filter self-rescuers and self-contained self-rescuers when planning and executing escapes from heavy smoke on a mine section |
| 6. EE/SR | Ordering | Priorities and decisions when faced with a hostile environment and insufficient time and means for all miners to escape from a mine section |
| 7. EE/SR | Evaluate Judge Debate | Merits and risks of using self-contained self-rescuers for the rescue of miners trapped in smoke as opposed to the use of this apparatus only for self-rescue |

³ Skill and knowledge domain abbreviations:
 EE = evacuation and escape
 SR = self-rescue
 MG = mine gases

Master Answer Sheet for Escape From A Mine Fire

Use this answer sheet to mark your selections. Rub the developing pen gently and smoothly between the brackets. Don't scrub the pen or the message may blur. Be sure to color in the entire message once you have made a selection. Otherwise you may not get the information you need. The last part of the message will tell you what to do next.

Question A (Select as MANY as you think are correct.)

1. [Correct!]
2. [Correct!]
3. [Dangerous. He could be overcome.]
4. [You need to do something else first.]
5. [You need to act now.]
6. [Correct! To protect yourselves you should do so at the first sign of smoke.]

Question B (Select as MANY as think are correct.)

7. [Your FSR is sufficient for now. You need to warn the others and call outside.]
8. [When you leave, other miners may come to the power center and
[find SCSRs missing. They may think you have left the section.]
9. [You need to make sure all the other miners are warned and go to the
[assembly point by the power center.]
10. [Warning others to assemble is more important.]
11. [Correct! This is a proper procedure and is an additional warning for the crew
[that something is wrong.]
12. [Correct! Smoke is light. You are protected from CO. You need to warn others
[on the section and outside, and you need more information.]

Question C (Select as MANY as you think are correct.)

- 13. [Correct! All miners are present.]
- 14. [This wastes time. The return air must be contaminated.]
- 15. [This wastes time and won't help. You don't know the size and location of the
[fire. You need to leave immediately.]
- 16. [Correct! The FSRs will protect you from CO. The air in the belt entry looks
[fresh. It's a long way outside. You don't know where the fire is. You may need
[the SCSRs later.]
- 17. [This is a last resort. You have other and better options.]
- 18. [You don't know where the fire is. You can't see to tram the mantrip safely
[because of the thick smoke.]

Question D (Select as MANY as you think are correct.)

- 19. [The air looks clean but it could contain CO.]
- 20. [Correct! You may have a long way to go through smoke to get outside. Your
[FSR should protect you from CO.]
- 21. [This eliminates the protection from CO provided by the FSR.]
- 22. [Correct! But, the miner returns and says the pager is no longer working.]
- 23. [Correct! This may be useful.]
- 24. [Correct! You may need these.]
- 25. [While you might need these before you get outside, looking for them and
[carrying them will slow you down.]
- 26. [Correct! You find a 40' length of telephone cable.]

Question E (Select as MANY as you think are correct.)

27. [Correct! You need to do this now while you still have some visibility. CO]
[levels may also increase and oxygen levels decrease.]
28. [This could be dangerous if the smoke becomes heavier and the air worse.]
29. [Correct! But, it is difficult to cross the belt. Besides, the smoke is so]
[thick you can't tell when you're in a crosscut.]
30. [It is difficult to cross the belt. Besides, the smoke is so thick you can't tell]
[when you're in a crosscut. You know there is smoke on the belt, so the air]
[in the return entry also must be contaminated.]

Question F (Select as MANY as you think are correct.)

31. [Correct! The buddy system is a good idea.]
32. [Correct! This can help reassure the miners.]
33. [Correct! They may need their FSRs later.]
34. [Correct! It is now 10:15 A. M. . You may need this information. Twenty]
[minutes can seem like an hour when you are in danger.]
35. [Correct! The O₂ should be activated, the mouthpiece properly inserted and]
[sealed, the nose clip on, and the straps adjusted.]

Question G (Choose only ONE unless you are told to "Try again!")

36. [You need to deal with the problem. Try again!]
37. [You shouldn't assume his SCSR is malfunctioning. Try again!]
[]
38. [Correct! It is Tommy. He is next to last in line. He is weak and gasping for]
[breath. When you check, his SCSR appears to be working properly. Do the]
[next question.]
39. [His problem may be one that can be corrected. Try again!]

Question H (Choose only ONE unless you are told to "Try again!")

- 40. [This could endanger the lives of the entire crew. It's a long way out and you]
[don't know where the fire is. Try again!]
- 41. [Correct! They may be able to get out and get help. Do the next question.]
- 42. [There is not enough room. This requires too much time and effort. This hard]
[work would soon deplete the supply of oxygen in their SCSRs. Try again!]

Question I (Choose only ONE unless you are told to "Try again!")

- 43. [You or Pete may need that SCSR to get out and get help for Tommy. Try]
[again!]
- 44. [There is a better way to help Tommy. Try again!]
- 45. [Correct! There are no better options at this time. Do the next question.]
- 46. [You can't. You are both too exhausted to continue. Try again!]

Question J (Select as MANY as you think are correct.)

- 47. [Correct! SCSRs are approved only for self-rescue.]
- 48. [Correct! This is the best way to help Tommy at this time.]
- 49. [SCSRs are approved only for self-rescue.]
- 50. [Correct! This equipment is approved for rescue.]

Question K (Write your answer on the blank lines.)

51.

Question L (Choose only ONE unless you are told to "Try again!")

- 52. [People often play Monday morning quarterback and praise or criticize a]
[person's actions based on the outcome, not the merit of the action itself. But]
[this is wrong. Try again!]
- 53. [People often play Monday morning quarterback and praise or criticize a]
[person's actions based on the outcome, not the merit of the action itself. But]
[this is wrong. Try again!]
- 54. [Correct! That is why you were not told whether Tommy and those who tried]
[to rescue him lived or died. You should decide the merit of their actions]
[without knowing the outcome. Do the next question.]
- 55. [The exercise and the problems involved are real and based on actual mine]
[fires and accident reports about them. Try again!]

Question M (Select as MANY as you think are correct.)

- 56. [Both SCSRs were probably O.K. and fully charged.]
- 57. [This is unlikely.]
- 58. [Correct! This is very likely and it would rapidly decrease the amount of]
[remaining oxygen in your SCSRs.]
- 59. [Correct! Dragging and lifting another heavy miner in a confined area like the]
[walkway along the belt line is very hard work.]
- 60. [The SCSRs could have been of either type. Both types provide extra oxygen]
[(up to a certain limit) as the individual works harder.]

Question N (Write your answer on the blank lines.)

Finding your score

Number of "Correct" answers you colored in

31 minus number of incorrect answers you colored in

Add blanks one and two to get your total score

Highest possible score = 59

Lowest possible score = 0

Discuss your answers to questions K and N with your classmates and instructor.

Determine what you think are the best answers.

Instructor's Discussion Notes for Escape From A Mine Fire

Use the information presented here and on the master answer sheet, your own ideas and experience, and those of the miners in your class, to discuss the exercise after it is completed. Group discussion can strengthen knowledge and skills, correct errors, and relate the exercise content to the experiences of the miners. After they have worked the exercise, miners enjoy discussing the problem. They also frequently think of better ways to respond to a problem than those listed among the answers. The purpose of the exercise is to help miners think about and remember basic knowledge and skills they may someday need to deal with an emergency. The discussion following the exercise can contribute to this goal and tailor the exercise content to the needs of the group you are training.

It is helpful to show overhead transparencies of the master answer sheet during the discussion while the miners look at their problem booklets. This allows you to lead the group through the exercise and to disclose and discuss all the answers to each question. Most of the information about why particular answers are correct or incorrect is given on the master answer sheet.

The following notes provide additional information for you to discuss with your class. Read through and think about the notes before the class. Incorporate the ideas you find here with your own ideas and make these points at the appropriate place in the discussion of the exercise.

Question A - The correct answers are (6) to immediately don the FSRs, (2) to send the mechanic to call outside, report the fire, ask for information about the fire and its location, and to wait by the pager for additional information, and (1) to go to the face to warn the crew members and have them assemble. It is important that the foreman and mechanic don their FSRs before doing these other things. The smoke could be contaminated with CO. Telling the mechanic to travel outby the intake entry to locate the fire (3) would send him into the smoke. This is dangerous and it would waste time. Other methods should be used to attempt to determine the location of the fire. These include asking for this information from surface personnel and checking the #2 entry at each mandoor as the foreman and crew leave the section by the belt entry in neutral air. Immediately running to the power center and donning an SCSR (4) is not a good action at this point because during this travel the foreman and mechanic would be unprotected from CO unless they first donned their FSRs. In addition, once they had donned their FSRs, stopping to don the SCSRs would take extra time and delay warning and assembling the crew. Crew members who happened to come to the assembly point after the foreman and mechanic had left with two SCSRs might also think these two persons or others had already left the section. This misunderstanding could create confusion and alarm that could delay escape. The FSRs should provide adequate protection during the short time it would take for the foreman and mechanic to warn and assemble the crew and to call outside. Watching the smoke for awhile to see if it will subside (5) is unwise. Precious time could be lost. Although this seems an unlikely response, studies of human behavior in fires in factories, hospitals, and other large structures suggest this is a common response. (See the references at the end of these notes.) Interviews with miners who have been involved in fires suggest that miners also

often wait for smoke to clear before taking positive action. The smoke is often attributed to a small cable fire or some similar short-lived source.

Question B - The correct answers are (11) to de-energize the power center, and (12) to leave their FSRs on while the foreman and mechanic go to the face to warn the other miners and to call outside. These are the priority actions at this time. Taking SCSRs from the cache at the power center (8), and donning SCSRs at this time (7) are unwise for the reasons discussed in the notes for Question A. The missing apparatus may alarm and confuse any miners who come to the assembly point. The foreman's stopping to don an SCSR will delay warning and assembling the others. The FSRs provide adequate protection to the foreman and mechanic while they warn others and report the fire. Stopping to check the condition of the SCSRs and laying them out to make donning easier (10) would waste precious time. Anyway, the condition of SCSRs should be checked daily at the beginning of the shift, and the neck straps and position of the units should always be arranged to facilitate rapid donning. These tasks should have already been attended to.

Question C - The correct answers are (13) to make a head count to see if all the miners are assembled, and (16) to tell each miner to don his FSR and move into the belt entry immediately. (Note: Some experts argue that the SCSRs should be donned immediately, and that the FSRs should not be used in this situation.) At this point the foreman knows the air in the belt entry is free of smoke. It is best to quickly move the crew into this smoke free environment before donning the SCSRs, but it is also a good idea to have the miners don their FSRs before moving to the belt entry. Donning the FSRs will take only a few seconds, and it will protect the miners from CO that may be present in the smoke, or that may be in the smoke-free air in the belt entry. Smoldering fires can produce large amounts of CO with little apparent smoke. It is possible that the CO level in the apparently clear neutral air of the belt entry could be higher than the CO level in the smoke-filled intake air and return entries. It is unnecessary to send anyone to check the return entry for smoke (14). Because of the mine ventilation arrangements, the return aircourse must be contaminated with smoke. Hanging a check curtain across the intake air entry at crosscut #19 (15) is likely to make the situation worse. Stopping the flow of intake air to the face and out the return would tend to force the smoke-filled intake air into the neutral air in the belt entry. (All brattices have some leakage.) This would compromise the one good escape route available to the miners. Traveling out the intake air entry in the mantrip in heavy smoke (18) could be the fastest and best way to leave the section if the mantrip were a rail track vehicle, and if the miners first donned their SCSRs. In this mine a rubber tired vehicle serves as the mantrip. The rough roadway and the heavy smoke make it unlikely that the mantrip could be trammed effectively from the section. At this point there is no reason to barricade (17), the face area is a poor place to do so, and the activity would waste valuable escape time. It is far better to attempt a prompt escape from the section.

Question D - The keyed correct answers are (20) having miners leave their FSRs on and travel outby while carrying their SCSRs, (22) sending a miner to the pager to call out to learn more about the location and size of the fire and to report that the section is being evacuated, (23) taking the section escape map and (24) taking extra SCSRs along during the departure, and (26) looking for something close by that could be used

as a lifeline to help keep the mine crew together. It would also be correct to have the miners remove their FSRs and don their SCSRs before leaving the section. In fact, many experts argue that the correct action is to immediately don the SCSRs before leaving the section, and that the FSRs should not be used. Ask the members of your class to debate the merits of these choices. In the real-life cases upon which this exercise is based, the miners did not want to put their SCSRs on right away because they were nearly three miles from the portal and did not know the location of the fire. The miners wanted to travel without using their SCSRs if possible, realizing that if the fire were near the mine portal they did not have enough oxygen to escape. Removing the FSRs (19) might make travel easier, but could also be a fatal error if CO is present in the belt entry. Sending the miners to get their lunch boxes and water (25) would waste valuable time. If some of the miners had their lunch buckets with them, it would be all right for them to bring these along, provided these items did not slow their escape.

Question E - The correct answers are (27), telling everyone to don their SCSRs, and (29) checking the air in the intake entry at the next mandoor. At this point the miners have traveled only five crosscuts outby and have encountered heavy smoke with poor visibility. It is imperative that the SCSRs be donned immediately before the smoke becomes worse. CO levels may increase and oxygen deficiency may develop. These conditions make continuing the escape with FSRs dangerous (28). (It should also be noted that those persons who argued that the SCSRs should have been donned earlier in place of the FSRs have a good point.) Moving to the secondary escapeway in the #1 entry (30) would be foolish and waste time. The #1 entry is the return aircourse for the section. It would be filled with smoke.

Question F - The correct answers are (31) telling crew members to help one another don their SCSRs, (32) offering your assistance to those that need help, (33) reminding the miners to keep their FSRs with them in case they need these later if their SCSRs run out of oxygen, (34) making note of the time when the SCSRs were donned, and (35) checking each miner's SCSR once he has donned it to see that it is properly activated and fitted. There are no wrong answers to this question. All of these activities should be completed if the miners are to be properly prepared to escape.

Question G - The correct answer is (38) finding out who is in trouble and checking on this person and his SCSR. It is unlikely that other miners would ignore Tommy's problem (36). Giving Tommy an unopened SCSR (37) without first checking the SCSR he is wearing could waste a unit that may be needed later. At this time, abandoning Tommy (39) is not appropriate. At this point the foreman doesn't know the reason for Tommy's problems. The foreman should attempt to identify and correct the problem and help Tommy move out of the mine.

Question H - The correct answer is (41), to split up and let the miners who can move faster leave the section by following the belt out. At this point it is clear that Tommy's problem is his physical inability to sustain an adequate pace as the group leaves the section. Telling the other miners to hang on to the lifeline and stay with Tommy (40) reduces their chances of escape and endangers their lives. These miners may also be able to get help for the foreman and Tommy. Tommy's weight, the poor visibility, the narrow and low walkway along the belt, and the effort required conspire to make

carrying or dragging Tommy out of the mine (42) dangerous and impractical. When mine safety personnel and miners think and talk about escaping from a mine, they seldom realize that there are almost always some miners who will be very fit and easily able to move rapidly out of the mine, while other miners will be less fit and experience difficulty. Some miners may not know the way out of the section or the mine, while a few others may. Interviews with miners who have escaped from serious mine fires suggest that these types of problems are often present and that they require difficult decisions about how to proceed with the evacuation.

Question I - The correct answer is (45) for the foreman and Pete to leave Tommy, take the unused SCSR with them, and go for help. In the 25 minutes the foreman and Pete have been helping Tommy they have moved only 10 crosscuts. Carrying and lifting Tommy after he has repeatedly fallen has fatigued his two rescuers, and has also depleted their oxygen supply. They would be unable to drag him further (46). Tommy is in such bad shape that putting the unused SCSR on him (43) would probably not be effective. Unless he was coherent he would not keep the mouthpiece in place and would not benefit from the apparatus. It would also be difficult and take a long time to get the unit on him because of his condition, the heavy smoke, and the fatigued state of the foreman and Pete.

Question J - The correct answers are 47, 48, and 50. The foreman should tell the two miners not to attempt a rescue of Tommy using their SCSRs (47). The smoke is too thick and the risk too great. Even if they find Tommy, the two miners will have trouble dragging him out because of his weight and size, the confined space in the belt entry, the poor visibility, and restrictions on their physical capabilities because of their wearing SCSRs. SCSRs are not mine rescue equipment. The would-be rescuers could become disoriented, lost, and themselves become casualties. The best way the foreman can help Tommy is to have all the miners fight the fire and restore proper ventilation to the section as soon as possible (48), while at the same time calling for mine rescue equipment (50).

Question K - The miners involved in the field tests of this exercise and other similar exercises debate this issue. While all persons recognize the good intentions of the two miners who want to use SCSRs to rescue Tommy, they disagree on the merit of the attempt. Experienced mine rescue personnel and other experts argue that it is very difficult to travel and work in smoke while wearing SCSRs, and that the risks are too great to attempt a rescue of Tommy. The potential problems with such an attempt are described in the notes for the previous question. Encourage the members of your class to debate the issues involved in this question.

The responses of the 96 persons in the field test of the exercise are listed in the following table.

What do you think about the two miners' attempt to rescue Tommy?

| Response | Frequency | Summary of Comments Content |
|--------------------------------|-----------|--|
| Yes, should go. | 29 | |
| | 12 | They should go get Tommy. |
| | 6 | I would try to rescue him. |
| | 6 | A normal human (moral) decision. |
| | 4 | Necessary to save his life. |
| | 1 | I would not stop them. |
| No, should <u>not</u> go. | 40 | |
| | 27 | Should wait for mine rescue team and/or mine rescue equipment. |
| | 9 | Too risky. SCSRs not designed for rescue. |
| | 2 | Wait until control fire first. |
| | 1 | Tommy is probably already dead. |
| | 1 | Tommy will die if try to rescue with SCSRs. |
| Probably should go. | 10 | |
| | 1 | Should be better equipped, but I would probably try |
| | 5 | Brave but foolish |
| | 4 | Should let the miners decide for themselves |
| Probably should <u>not</u> go. | 2 | Would commend the men for bravery, but instruct them not to go in. |
| Did not respond. | 15 | |

Question L - The correct answer is 54. Such rescue attempts should be judged on the merits of their feasibility, likelihood of success, and relative risk to the rescuers. Such judgments should be fully informed by accurate knowledge of how difficult it is to travel in heavy smoke and do hard physical work while wearing an SCSR. It is inappropriate to judge the merits of such attempts based on the outcome. Why? Because when the decision has to be made by the would-be rescuers, the outcome cannot be known, and cannot be the basis for the decision. Only the relative risks can be assessed and then the decision made. This exercise is not just a "story" (55). It was constructed from interviews of miners who escaped from a fire like the one in the exercise. In the real-life situation the two miners who attempted the rescue of Tommy were successful, but this

was in part because the other miners who fought the fire were able to rapidly improve the ventilation to the section. Tommy also survived.

Question M - The correct answers are 58 and 59. The foreman's, Pete's, and Tommy's SCSR oxygen supplies were depleted more rapidly than normal because their repeated falling down onto the breathing bag dumped oxygen, and because the hard work involved in assisting Tommy required the use of more oxygen by the other two men. The temperature of the units (57) was not a factor. (Chemical units that are at or below freezing produce oxygen at lower rates than normal until the unit warms up from the miner's breath. Pressurized oxygen SCSRs are not affected by this condition.) Both pressurized oxygen and chemical SCSRs are designed to deliver more oxygen (up to a limit) as it is needed by the miner. The pressurized oxygen units use a mechanical demand valve that opens and allows more oxygen to be delivered when the miner breathes harder. The chemox units produce more oxygen when the miner breathes faster and deeper because the extra water vapor and CO₂ in the miner's breath speeds up the chemical reaction with the KO₂ in the SCSR.

Question N - Ask the miners in your class to share their answers to this question. Discuss the merits of different the different approaches. At the appropriate points, incorporate the information that follows in your class discussion.

Accident investigations and recent interviews with many coal miners who have escaped from serious underground fires reveal that miners seldom don FSRs or SCSRs at the first sign of smoke. Generally these miners delayed from 10 to 15 minutes or longer until the smoke became thick and irritating. When asked why they did this, most miners said they were worried they might have too little oxygen to escape the mine fire, and that they wanted to save the SCSRs until they really needed them. The miners interviewed were two to three miles from the portal, and they did not know the location of the fire. They were afraid the one hour rated oxygen supply in the SCSR would not give them time enough to escape from the mine if the fire was near the portal.

The miners in these situations also did not first don their filter self-rescuers before donning their SCSRs. When they were asked about this it appeared that they (1) forgot about these units, and (2) felt that they could move safely and faster in apparently clean air, and even in moderate to heavy smoke without using either the FSR or SCSR.

These interviews with approximately 40 miners, and earlier interviews with many other miners who have escaped fires, suggest that delaying the donning of FSRs and SCSRs is very common, even in serious fires with much smoke. It is likely that other miners may behave the same way when they experience mine fires and smoke. The delay in donning FSRs and SCSRs is dangerous because during a mine fire carbon monoxide can be present even in apparently clear air, and is likely to be present in rapidly incapacitating and fatal concentrations when smoke is present. Discuss what can be done to assist miners to safely exit mines during fires, and to encourage the proper use of emergency breathing apparatus. Compare your ideas and those generated by your class members to the following list developed by a group of mine rescue personnel and mine safety researchers.

- 1) Simply conducting more training that admonishes miners to "don their SCSRs at the first sign of smoke" would probably not be effective. All the miners interviewed knew that they were to do this. Yet they did not comply with the procedure for the reasons discussed above.
- 2) Placing extra SCSRs on mantrips and caching them at well marked locations along escape ways are good ways to encourage miners to don their SCSRs early at the first sign of smoke. Many mines currently follow this practice. Potential problems are that miners may have to use escape routes that do not take them by the extra SCSRs, and they may have difficulty locating the cache if the smoke is very heavy. Changing from one unit to another under stressful conditions in heavy smoke is also difficult and dangerous.
- 3) Interviews with miners who have escaped fires, and review of many accident investigations reveal that in most cases the underground mine crews did not know the location of the fire. Yet the person who found and reported the fire to the surface often knew the location of the fire. The surface personnel who called in to a mine section and told the crew about the fire also often had information about the location of the fire. Yet, this information often was not communicated to the miners who were in danger. In addition, the miners who had to escape working sections usually failed to ask for the location of the fire when they were talking with surface personnel who had called the section to give the evacuation order. Information about the location and size of a fire can be lifesaving. The absence of this information can be fatal. This knowledge is needed to plan escape routes and strategy. Mine fire drills and classroom training should emphasize the importance of the communication of this information among all persons involved.
- 4) With carbon monoxide detectors, mine crews can determine if CO is absent or below danger levels. A flame safety lamp or oxygen measuring instrument could be used to determine if sufficient O₂ is present. If CO is absent or present only at extremely low levels, and if O₂ levels are adequate, the miners can continue traveling out of the mine in apparently clear air, and even in smoke without donning their FSRs or SCSRs. This tactic would make it easier for miners to travel and also help "save" the SCSR for when it was needed should CO or oxygen deficient air be encountered during the escape. Electronic hand-held CO detectors about the size of a calculator are available from a number of companies. These instruments are durable, use batteries that last from 6 months to a year, and give continuous read-outs of CO from 0 up to 1999 ppm. The more expensive instruments flash blinking digital displays and sound audible alarms at danger levels of from 50 ppm to 200 ppm (or within some similar range the user prefers). The equipment required to calibrate these instruments is available. Any one mine would need only one calibration apparatus. A mine could equip each face crew with a hand-held CO detector for about the same price as one additional SCSR.

Less expensive packs of CO stain tubes and hand operated air sampling pumps can also be used in a similar manner. One pump and one package of stain tubes could be stored with each cache of SCSRs. During an escape from a fire the foreman or another miner could monitor the air with the hand pump and the stain

tube. The shelf life of the tubes is about three years. The equipment requires no batteries or power source.

- 5) If miners do not know the location of a fire, if they have no rapid transportation out of the mine, and if they are worried they may have too little oxygen in their SCSRs to escape the mine, they could, as a first step, don their FSRs. The FSR provides protection up to one hour for concentrations of CO up to 1.0 percent or 10,000 ppm, although the unit rapidly becomes blistering hot at this high concentration (30 CFR11.102-5). A good strategy might be to first don the FSR, to take the SCSR along, and to pay attention to the temperature of the FSR. (When it starts to get hot, CO must be present.) As soon as the FSR begins to get warm, the miner could stop, don the SCSR, and continue on. The danger in this procedure is taking breaths of the mine atmosphere during the changeover procedure. This could prove to be fatal. That is why it is better to don the SCSR initially and at the first sign of smoke, if this is possible. Even if miners do don SCSRs, the FSRs should not be discarded, but kept on the miner's neck swung around to the rear. If re-donned, the FSR could still prove protection against deadly levels of CO if and when the oxygen in the SCSR became depleted.

Miners often lack knowledge of CO and its effects. You may wish to share some of the following information with members of your class. These facts may help miners to understand the importance of rapid protection of one's body from CO intoxication by the use of emergency breathing apparatus.

Even very small amounts of CO are dangerous. This colorless gas has no odor or taste. The hemoglobin in the red blood cells has an approximately 300 times greater affinity for CO than for O₂. This means that even a very small amount of CO in the mine atmosphere is rapidly concentrated to dangerous levels within the red blood cells and the body tissues. CO also binds tightly to the hemoglobin, remains in place for a long time, and prevents oxygen from entering the red blood cells and the body tissues. Thus, recovery from CO intoxication requires several hours, even when the victim has been moved to fresh air. CO intoxication can produce unconsciousness, permanent brain damage, and death. The consequences are related to the concentration and exposure time. Exposure to a concentration of 0.10 percent CO (1,000 ppm) can produce headache, weakness, dimness of visions, mental incapacitation, and nausea within 30 to 45 minutes, collapse and unconsciousness within an hour, and death within 90 minutes. Longer exposure times to smaller concentrations can produce the same effects. For example exposure to CO concentrations of 0.04 percent (400 ppm) can lead to unconsciousness in a little over two hours and to death in approximately four hours (Hartman, Mutmansky, & Wang, 1982, pp. 43-46). Mine atmospheres with concentrations of from 1 to 2 percent CO (10,000 to 20,000 ppm) or even higher levels are likely after a methane or dust explosion and in certain types of fires. One breath of such an atmosphere can incapacitate a person and a second or third breath can render them unconscious. Death follows within a few minutes (Green, Althouse, Frost, Wheeler, & Shores, 1986). This is why the FSR and/or the SCSR should be donned immediately when smoke is present. During a mine fire or explosion the CO levels in the mine air at any given location can change drastically and rapidly as the mine ventilation

system distributes contaminated air to other locations. Delaying donning protective breathing equipment can prove fatal.

For convenience, Figure 1 plots equivalent percent concentration and parts per million values. Use the chart to convert one value to the other.

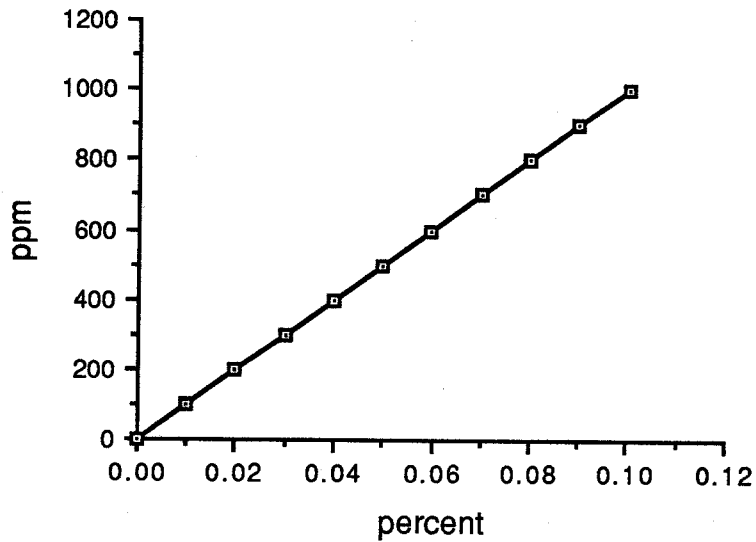


Figure 1: Equivalent ppm and percent concentrations

References

- Applied Science Associates, Inc. & Gates Engineering Company. (undated). A training program for fighting small fires in underground mines. Pittsburgh: U. S. Bureau of Mines.
- Best, R. L. (1977). Reconstruction of a tragedy: The Beverly Hills Supper Club Fire. Washington, DC: National Fire Protection and Control Administration. (NFPA No. LS-2).
- Bryan, J. L. (1983). A review of the examination and dynamics of human behavior in the fire at the MGM Grand Hotel, Clark County, Nevada, as determined from a selected questionnaire population. Fire Safety Journal, 5, 233-240.
- Bryan, J. L. (1978). Human behavior in fire - A bibliography. Washington, DC: Center for Fire Research, National Bureau of Standards. (Report No. NBS-GCR-77-94).
- Canter, D. (Ed.). (1980). Fire and human behavior. Chichester: Wiley.
- Office of the Federal Register. (1988). Code of Federal Regulations. Parts 1 to 199. 30 CFR 11.102-5, pp. 51-53. Washington, DC: U. S. Government Printing Office.
- Green, F. H. Y., Althouse, R., Frost, J. L., Wheeler, R. W., & Shores, S. K. (1986). Forensic investigations of coal mine fatalities. In R. W. Wheeler (Ed.), International Conference on the Health of Miners, Annals of the American Conference of Governmental Industrial Hygienists, Volume 14 (pp. 117-124). Cincinnati, OH: American Conference of Governmental Industrial Hygienists.
- Hartman, H. L., Mutmansky, J. M., & Wang, Y. J. (1982). Mine ventilation and air conditioning, second edition. New York: Wiley.
- Miller, R. M., & Borda, M. (1988). Report of investigation (underground coal mine): Non-injury machinery fire. Mine ID No. 36-00840, Cambria County, PA: MSHA, Coal Mine Health & Safety, District 2.
- Shumate, J. L. (1985). Mine Escapeways. Mine Safety and Health Administration. Safety Manual No. 11. Beckley, WV: National Mine Health and Safety Academy.

Scoring Key for Escape From a Mine Fire

The correct answers are marked with an asterisk.⁴

| Question | Answer Number | | | | | | | |
|----------|---------------|-----|-----|-----|-----|-----|----|-----|
| A | 1* | 2* | 3 | 4 | 5 | 6* | | |
| B | 7 | 8 | 9 | 10 | 11* | 12* | | |
| C | 13* | 14 | 15 | 16* | 17 | 18 | | |
| D | 19 | 20* | 21 | 22* | 23* | 24* | 25 | 26* |
| E | 27* | 28 | 29* | 30 | | | | |
| F | 31* | 32* | 33* | 34* | 35* | | | |
| G | 36 | 37 | 38* | 39 | | | | |
| H | 40 | 41* | 42 | | | | | |
| I | 43 | 44 | 45* | 46 | | | | |
| J | 47* | 48* | 49 | 50* | | | | |
| L | 52 | 53 | 54* | 55 | | | | |
| M | 56 | 57 | 58* | 59* | 60 | | | |

⁴ This page is printed in large type so that it may be copied and used as an overhead transparency.

Appendix A: Problem Booklet

Duplicate this copy of the problem booklet for use in your classes. **Booklets should be printed on only one side of the paper.** Each person in your class should have a problem booklet while they are working the exercise. The problem booklets are reusable.

You may obtain a copy of the problem booklet from MSHA, National Mine Health & Safety Academy, Dept. of Instructional Materials, 1301 Airport Road, Beaver, WV 25813-9426 phone 304-256-3257, fax 304-256-3368 or email to lord-mary@msha.gov.

Escape From A Mine Fire

Problem Booklet

Instructions

Read the problem situation described on the next page. Next, answer each of the 14 questions. Do them one at a time. Don't jump ahead, but you may look back to earlier questions and answers. Some questions ask you to select all of the answers that you think are correct. Other questions ask you to select only one answer unless you are told to "Try again!" Follow the directions for each question.

After you have selected a choice to a question, look up its number on the answer sheet. Select your answer(s) to each question by rubbing the developing pen between the brackets on the answer sheet. A hidden message will appear and tell you if you are right. When you have finished, you will learn how to score your performance.

Background

You are the section foreman on the 3 Left longwall development panel.

You and seven miners are at work on the section today.

It is 10:00 a.m.

The seam height is 48 inches. Entries and crosscuts are cut 20 feet wide with pillars on 100' centers.

The face has advanced 2,500 feet from the mains.

It is 12,500 feet to the outside from the junction of this section with the mains. (it is 15,000 feet from the face of 3 Left to the portal.)

The designated primary escapeway is the #2 intake aircourse (14,000 cfm) and the secondary escapeway is the #1 return aircourse. (See Figure 1 on the next page.)

The crew travels to and from this section in the #2 entry in a rubber tired, battery operated mantrip. The mine bottom is rough and rutted.

Ten self-contained self-rescuers (SCSRs) are stored at the power center, the designated evacuation assembly point.

You and the rest of your crew had hands-on SCSR training 3 months ago.

Everyone is wearing a filter self-rescuer (FSR) on their belt.

Problem

You are the section foreman for the 3 Left development panel. You are checking on a mechanic who is working on a scoop in #2 entry at #19 crosscut. Suddenly you smell smoke. Turn the page and study Figure 1. Then turn to question A.

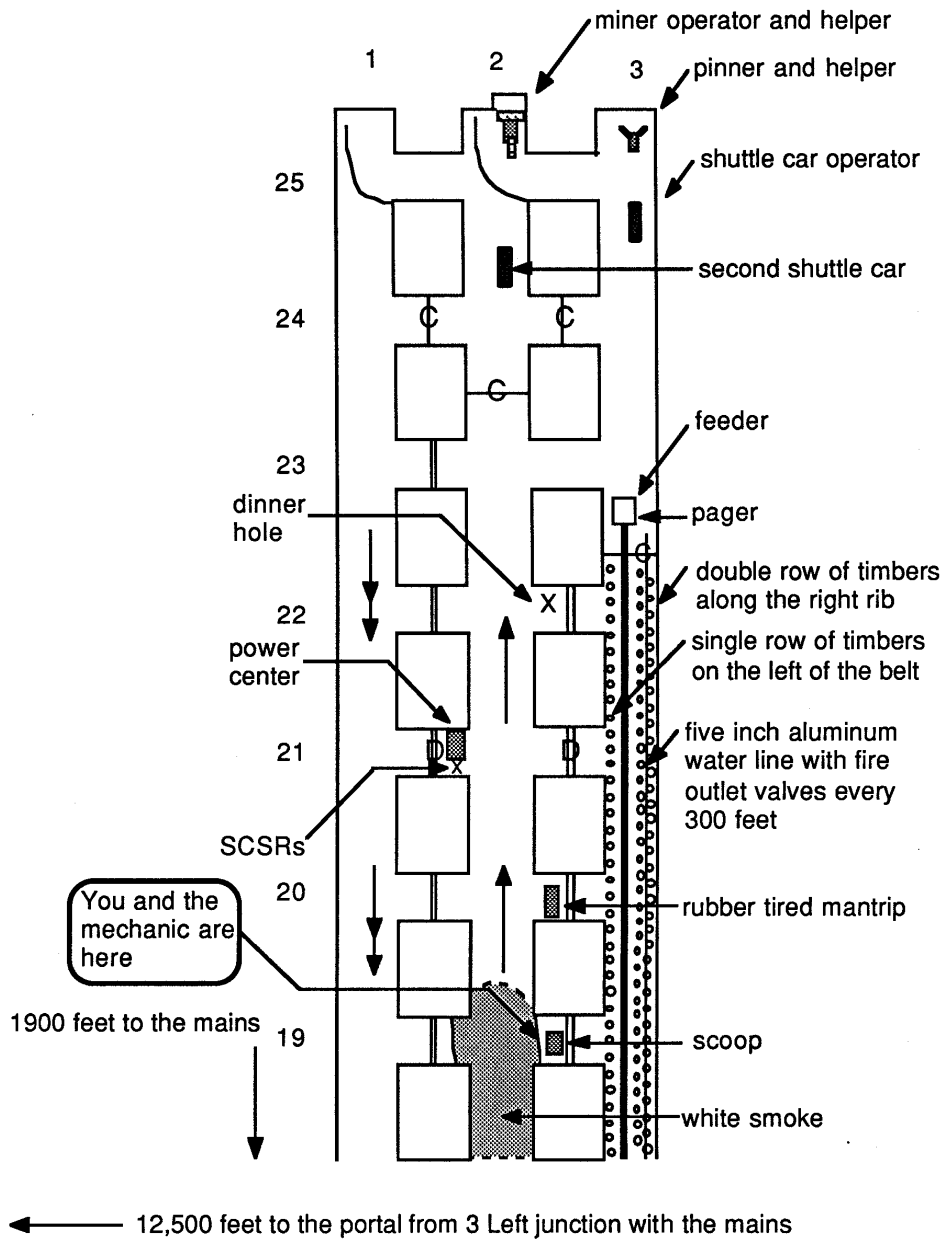


Figure 1: Section map for 3 Left (not to scale)

Question A

You look into the #2 entry and see light white smoke traveling toward the face. The entire entry is filled with smoke. What things should you do now? (Select as MANY as you think are correct.)

1. Go to the face and tell your crew to assemble at the power center.
2. Send the mechanic to call outside to report the smoke and have him wait by the pager for further instructions.
3. Tell the mechanic to travel out the intake and try to locate the source of the smoke.
4. Immediately run to the power center and don your SCSRs.
5. Watch the smoke for awhile to see if it subsides.
6. Immediately don your FSR and tell the mechanic to do the same.

When you have made your selection(s), do the next question.

Question B

While still in #19 crosscut, you and the mechanic put on your FSRs and then begin to move toward the face to warn the others and to call outside. As you approach the power center, you see the SCSRs. What should you do now? (Select as MANY as you think are correct.)

7. Stop at the power center and you and the mechanic each don an SCSR.
8. Tell the mechanic to grab a couple of SCSRs, and you grab a couple, and continue on to warn the others and to call outside.
9. Wait at the power center until the other miners assemble.
10. Stop and check the condition of each SCSR, and then lay them out to make it easier for the other miners to get the units on.
11. De-energize the power center.
12. Wearing your FSRs, go directly to the face area, to warn the others and to call outside.

When you have made your selection(s), do the next question.

Question C

You and the crew assemble at the power center by the SCSRs. The shuttle car operator and mechanic return. They report that they received a call from the surface. They were told there is a fire outby your position and the crew is to evacuate the section immediately. The mechanic says he checked the air in the belt entry and that it is clear. Not all the miners are wearing FSRs. The smoke is rapidly getting thicker. Visibility is now only 8 feet. What things should you do now? (Select as MANY as you think are correct.)

13. Make a head count.
14. Send the mechanic to the return (the secondary escapeway) to check for smoke.
15. Hang a check curtain across the #2 entry at #19 crosscut.
16. Tell each miner to don his FSR, grab an SCSR, and move into the belt entry.
17. Take the crew up to the pager, and prepare to barricade.
18. Tell everyone to get into the mantrip and travel out the intake air course.

When you have made your selection(s), do the next question.

Question D

You and the entire crew move into the belt entry at crosscut #21. The air in the entry looks clean. Everyone is wearing their FSR. What should you do now? (Select as MANY as you think are correct.)

19. Remove your FSRs so you can breathe easier and travel faster, and then start out the belt entry.
20. Leave your FSRs on, carry your SCSRs, and travel outby.
21. Keep your FSRs on, but remove the nose clip so it is easier to breathe as you move out.
22. Before you leave, send one miner to the pager to ask for information about the location of the fire, and to report you are walking out the belt entry.
23. Take the escape map with you as you prepare to leave the section.
24. Take the two extra SCSRs with you.
25. Send the miners to get their lunch buckets and water to take with them.
26. Look for something that you can use for a lifeline.

When you have made your selection(s), do the next question.

Question E

You and your crew travel five crosscuts outby and begin to encounter heavy smoke. Visibility is 4 feet. Traveling is difficult because the walkway between the belt and the timbers is only 3 feet wide, and the entry height only 48 inches. What should you do now? (Select as MANY as you think are correct.)

27. Tell everyone to don their SCSRs.
28. Continue on while wearing the FSRs to save the SCSRs for later.
29. At the next mandoor, move into the #2 entry (the primary escapeway), and check the air. If it is clear, go on out in the #2 entry.
30. Move into the secondary escapeway (#1 entry) and go on out.

When you have made your selection(s), do the next question.

Question F

You tell everyone to put on their SCSRs. You are arranged in a line, close together in the belt entry. Visibility is poor. What should you do now? (Select as MANY as you think are correct.)

- 31. Tell your crew to stay close together and to help each other.
- 32. Ask if anyone needs help.
- 33. Tell your crew to keep their FSRs with them as they go out.
- 34. Make note of and remember the time.
- 35. Go down the line, ask each miner if he is okay and check to see if his SCSR is properly donned.

When you have made your selection(s), do the next question.

Question G

Everyone gets their SCSRs on correctly. You tell each person to take hold of the lifeline and to move out with you leading the way. The group is moving very slowly. After you go what you estimate is about four crosscuts, the line stops. Someone yells. "I can't keep up! I gotta rest!" You note it is now 10:25 a.m. What would you do now? (Choose only ONE unless you are told to "Try again!")

- 36. Ignore the request and tell the group to continue on.
- 37. Find out who it is. Then give that miner an unopened SCSR
- 38. Find out who is in trouble.
- 39. Find out who is in trouble and tell that person to let go of the lifeline while you and the others move out.

Question H

Tommy, the miner having trouble, is overweight (260 lbs.) and out of shape. As you and the others continue to move out holding the lifeline, Tommy can't keep up. He has to stop every crosscut or so and rest for a minute or two. The smoke is getting heavier. What would you do now? (Choose only ONE unless you are told to "Try again!")

40. Tell everyone, "No matter what, hang on to the lifeline and stay together." "We'll make it out!"
41. Let the group split up, so the faster persons can leave the section.
42. Tell the crew to take turns and to use a four man carry to bring Tommy out.

Question I

You and Pete decide to stay with Tommy to help him out. The other miners go on ahead and follow the belt out. You keep one unused SCSR with you.

Tommy continues to have trouble breathing and moving. As you travel you keep track of the distance by counting the fire outlet valves on the water line that runs along the bottom between the timbers on your left. You can just barely see the water line through the heavy smoke. It takes you twenty-five minutes to go what you estimate is about 10 more crosscuts.

During this time, Tommy falls down many times. When he falls, you and Pete often fall with him. You and Pete have been working hard to help pull Tommy along, and you are nearly exhausted. None of you is able to get enough oxygen from your SCSRs to continue in this way. Finally Tommy falls down and you can't get him up. He is confused. He says, "I can't go on." You look at your watch and see it is now 10:50 A. M. What should you do now? (Choose only ONE unless you are directed to "Try again!")

- 43. Put the unused SCSR on Tommy.
- 44. Tell Pete to take the unused SCSR and go for help, while you stay with Tommy.
- 45. You and Pete should take the unused SCSR with you, tell Tommy you are going for help, and then go on out.
- 46. You and Pete should drag Tommy.

Question J

You and Pete leave Tommy. After about 5 more crosscuts you get into the mains. You turn right in the track entry and head for the portal, still in heavy smoke. After 5 more crosscuts you come into fresh air. Both you and Pete are completely out of oxygen. Your SCSRS are empty. You look at your watch and note it is now 11:05 A. M.

You meet the miners fighting the fire. You tell them where Tommy is. There is no mine rescue equipment on the scene. A couple of miners don fresh SCSRs, and start to go back for Tommy. The general mine foreman arrives at this time. What should the foreman do now? (Select as MANY as you think are correct.)

- 47. Tell the two miners not to go after Tommy using SCSRs.
- 48. Keep all the miners present working to control the fire and to improve the ventilation to the inby sections, including Tommy's position.
- 49. Tell the two miners it is O. K. for them to go get Tommy using their SCSRs.
- 50. Call outside and request that mine rescue equipment be sent immediately.

When you have made your selection(s), do the next question.

Question K

The two miners tell the general mine foreman they know where Tommy is, they know where the fire is, that it is nearly under control, and they are sure they can find their way in and bring him out. Then, they go into the section to bring Tommy out.

In your own words, explain what you think about the two miners' attempt to rescue Tommy. (Write your answer on the blank lines on the answer sheet.)

Question L

Most exercises like this one tell how the problem ended. This exercise does not say what happened to Tommy and the two miners who tried to rescue him. Why do you think this exercise is designed this way? (Choose only ONE unless you are told to "Try again!")

52. If you were told that Tommy and the two miners who tried to rescue him survived, then you would know that it was O.K. for these miners to use their SCSRs to save Tommy.
53. If you were told that Tommy and the two miners who tried to rescue him died, then you would know that it was wrong for these miners to use their SCSRs to save Tommy.
54. In real-life situations like this, miners must decide what to do without knowing what the outcome will be. The decision to use SCSRs to try to rescue another miner, or not to do so, must be made on the merits of the situation and not the outcome.
55. The whole exercise is just a story that could never happen. It would be untruthful to say how it ended.

When you have made your selection(s), do the next question.

Question M

Look back at Question J. When the section foreman (you) and Pete got out of the section, you had been breathing with your SCSRs for 50 minutes. Yet, both of your units were empty. Both units were rated as having a one hour supply of oxygen. Think about the whole problem. Which of the following reasons explain why your SCSRs ran out of oxygen before an hour had passed? (Select as MANY as you think are correct.)

- 56. The SCSRs must have been defective or not fully charged.
- 57. The SCSRs were probably operating at too high a temperature.
- 58. When Tommy kept falling down and knocked you and Pete down, all three of you probably squashed your breathing bags and dumped a lot of oxygen.
- 59. The very hard work of lifting and dragging Tommy along resulted in you and Pete having to use more oxygen from your SCSRs than would be normal.
- 60. The SCSRs being used must have been the compressed oxygen type and not the chemical type.

When you have made your selection(s), do the next question.

Question N

During safety training, miners are taught to put their SCSRs on at the first sign of smoke. Yet, from talking with many miners who have escaped serious mine fires, it is known that they often delay putting on their SCSRs until they have been in smoke for about 10 or 15 minutes or even longer times. These miners said they wanted to save the SCSRs until they "really need them." The miners were worried they might run out of oxygen before they could get to the surface. These miners also did not don their FSRs while they were traveling in the smoke before they donned their SCSRs. Many of them forgot about the FSR and others thought they could move faster in smoke unprotected until they started to feel the effects of any CO that might be present. Then, they could don an SCSR.

During a mine fire, using an FSR and/or delaying the donning of an SCSR is dangerous and can be fatal. Think about this problem. List some things that could be done to help miners make better use of their breathing apparatus and safely escape from a mine fire. (Write your answer on the blank lines on the answer sheet.)

End of Problem

Scoring your performance

1. Count the total number of responses you colored in that were marked "correct". Write this number in the first blank on the answer sheet.
2. Count the total number of "incorrect" responses you colored in. Subtract this number from 31. Write the difference in the second blank on the answer sheet.
3. The best score is 59. The worst score is 0.

Discuss your answers to questions K and N with your classmates and instructor.

Determine what you think are the best answers to these two questions.

Appendix B: Answer Sheet Blanks

These are the answer sheet blanks. Copies of these blank answer sheets may be duplicated in the normal fashion. However, the answers that are found within the brackets must be printed on these blank answer sheets in invisible ink. These answers are found in Appendix C. If you have the capability to print invisible ink, make copies of the blank answer sheets. Make a master of the answers that appear in Appendix C. Then print the invisible ink on the blank answer sheets, being careful to make sure all pages print and that the appropriate answers line up with the appropriate blanks. The Master Answer Sheet shows all the answers in their proper places.

Most companies and trainers prefer to obtain copies of the preprinted answer sheets from MSHA, National Mine Health & Safety Academy, Dept. of Instructional Materials, 1301 Airport Road, Beaver, WV 25813-9426 phone 304-256-3257, fax 304-256-3368 or email to lord-mary@msha.gov.

The exercise is designed to be used in small groups. You will need one answer sheet for each group of 3 to 5 persons in your class. The answer sheets are consumable. You will need a new set for each class.

A developing pen is also needed by each person who marks an answer sheet.

Answer Sheet for Escape From A Mine Fire

Use this answer sheet to mark your selections. Rub the developing pen gently and smoothly between the brackets. Don't scrub the pen or the message may blur. Be sure to color in the entire message once you have made a selection. Otherwise you may not get the information you need. The last part of the message will tell you what to do next.

Question A (Select as MANY as you think are correct.)

- 1. []
- 2. []
- 3. []
- 4. []
- 5. []
- 6. []

Question B (Select as MANY as think are correct.)

- 7. []
- 8. []
[]
- 9. []
[]
- 10. []
- 11. []
[]
- 12. []
[]

Question C (Select as MANY as you think are correct.)

- 13. []
- 14. []
- 15. []
[]
- 16. []
[]
[]
- 17. []
- 18. []
[]

Question D (Select as MANY as you think are correct.)

- 19. []
- 20. []
[]
- 21. []
- 22. []
- 23. []
- 24. []
- 25. []
[]
- 26. []

Question E (Select as MANY as you think are correct.)

- 27. []
[]
- 28. []
- 29. []
[]
- 30. []
[]
[]

Question F (Select as MANY as you think are correct.)

- 31. []
- 32. []
- 33. []
- 34. []
[]
- 35. []
[]

Question G (Choose only ONE unless you are told to "Try again!")

- 36. []
- 37. []
[]
- 38. []
[]
[]
- 39. []

Question H (Choose only ONE unless you are told to "Try again!")

40. []
[]

41. []

42. []
[]

Question I (Choose only ONE unless you are told to "Try again!")

43. []
[]

44. []

45. []

46. []

Question J (Select as MANY as you think are correct.)

47. []

48. []

49. []

50. []

Question K (Write your answer on the blank lines.)

51. _____

Question L (Choose only ONE unless you are told to "Try again!")

52. []
[]
[]

53. []
[]
[]

54. []
[]
[]

55. []
[]

Question M (Select as MANY as you think are correct.)

56. []

57. []

58. []
[]

59. []
[]

60. []
[]

Question N (Write your answer on the blank lines.)

Finding your score

Number of "Correct" answers you colored in

31 minus number of incorrect answers you colored in

Add blanks one and two to get your total score

Highest possible score = 59

Lowest possible score = 0

Discuss your answers to questions K and N with your classmates and instructor.

Determine what you think are the best answers.

Appendix C: Invisible ink Answers

These pages contain the answers that must be printed in the blanks of the answer sheet in Appendix B. These answers are spaced and sequenced correctly so that they exactly match up with the appropriate blanks on the answer sheet blank.

Once the answers have been printed in the answer sheet blanks, the developing pen reveals the formerly invisible printed message.

You may obtain preprinted answer sheets or you may prepare your own copies. To learn more about these options, and to determine how many answer sheets and developing pens you will need, see the introductory section of the Instructor's Copy.

Correct!

Correct!

Dangerous. He could be overcome.

You need to do something else first.

You need to act now.

Correct! To protect yourselves you should do so at the first sign of smoke.

Your FSR is sufficient for now. You need to warn the others and call outside.

When you leave, other miners may come to the power center and find SCSRs missing. They may think you have left the section.

You need to make sure all the other miners are warned and go to the assembly point by the power center.

Warning others to assemble is more important.

Correct! This is a proper procedure and is an additional warning for the crew that something is wrong.

Correct! Smoke is light. You are protected from CO. You need to warn others on the section and outside, and you need more information.

Correct! All miners are present.

This wastes time. The return air must be contaminated.

This wastes time and won't help. You don't know the size and location of the fire. You need to leave immediately.

Correct! The FSRs will protect you from CO. The air in the belt entry looks fresh. It's a long way outside. You don't know where the fire is. You may need the SCSRs later.

This is a last resort. You have other and better options.

You don't know where the fire is. You can't see to tram the mantrip safely because of the thick smoke.

The air looks clean but it could contain CO.

Correct! You may have a long way to go through smoke to get outside. Your FSR should protect you from CO.

This eliminates the protection from CO provided by the FSR.

Correct! But, the miner returns and says the pager is no longer working.

Correct! This may be useful.

Correct! You may need these.

While you might need these before you get outside, looking for them and carrying them will slow you down.

Correct! You find a 40' length of telephone cable.

Correct! You need to do this now while you still have some visibility. CO levels may also increase and oxygen levels decrease.

This could be dangerous if the smoke becomes heavier and the air worse.

Correct! But, it is difficult to cross the belt. Besides, the smoke is so thick you can't tell when you're in a crosscut.

It is difficult to cross the belt. Besides, the smoke is so thick you can't tell when you're in a crosscut. You know there is smoke on the belt, so the air in the return entry also must be contaminated.

Correct! The buddy system is a good idea.

Correct! This can help reassure the miners.

Correct! They may need their FSRs later.

Correct! It is now 10:15 A. M. . You may need this information. Twenty minutes can seem like an hour when you are in danger.

Correct! The O₂ should be activated, the mouthpiece properly inserted and sealed, the nose clip on, and the straps adjusted.

You need to deal with the problem. Try again!

You shouldn't assume his SCSR is malfunctioning. Try again!

Correct! It is Tommy. He is next to last in line. He is weak and gasping for breath. When you check, his SCSR appears to be working properly. Do the next question.

His problem may be one that can be corrected. Try again!

This could endanger the lives of the entire crew. It's a long way out and you don't know where the fire is. Try again!

Correct! They may be able to get out and get help. Do the next question.

There is not enough room. This requires too much time and effort. This hard work would soon deplete the supply of oxygen in their SCSRs. Try again!

You or Pete may need that SCSR to get out and get help for Tommy. Try again!

There is a better way to help Tommy. Try again!

Correct! There are no better options at this time. Do the next question.

You can't. You are both too exhausted to continue. Try again!

Correct! SCSRs are approved only for self-rescue.

Correct! This is the best way to help Tommy at this time.

SCSRs are approved only for self-rescue.

Correct! This equipment is approved for rescue.

People often play Monday morning quarterback and praise or criticize a person's actions based on the outcome, not the merit of the action itself. But this is wrong. Try again!

People often play Monday morning quarterback and praise or criticize a person's actions based on the outcome, not the merit of the action itself. But this is wrong. Try again!

Correct! That is why you were not told whether Tommy and those who tried to rescue him lived or died. You should decide the merit of their actions without knowing the outcome. Do the next question.

The exercise and the problems involved are real and based on actual mine fires and accident reports about them. Try again!

Both SCSRs were probably O.K. and fully charged.

This is unlikely.

Correct! This is very likely and it would rapidly decrease the amount of remaining oxygen in your SCSRs.

Correct! Dragging and lifting another heavy miner in a confined area like the walkway along the belt line is very hard work.

The SCSRs could have been of either type. Both types provide extra oxygen (up to a certain limit) as the individual works harder.