Smoke on the Section

Instructor's Copy

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[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.

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Appendices

- Appendix A: Problem booklet (duplicate this copy for use in class)
- Appendix B: Answer sheet blank (print the answers on this)
- Appendix C: Invisible ink answers (print these on the answer sheet)

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.

Type:	Invisible ink
Length:	Ten questions (20 minutes administration plus 30 minutes for discussion)
Skills:	Escape from smoke Basic ventilation procedures Selecting good evacuation routes and procedures Fire fighting First aid for a blow to the head
Location:	Underground
Problem:	Big Tim and you are working on a super section. You are in the #1 entry (return air course) at the face replacing bits on a continuous miner when heavy smoke comes down on you fro somewhere on the section. You have your filter self-rescuer. Tim left his in the #8 entry. You have to find a way to help Tim, plan a good route to travel through the smoke to warn others and get help, and help locate and fight the fire.

[2] You can do this yourself if you have the proper equipment, or you may obtain copies of preprinted answer sheets from NIOSH, Pittsburgh Research Laboratory, Pittsburgh, PA phone 412-386-5901, fax 412-386-5902 or email to minetraining@cdc.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 maps 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 an exercise 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 doing 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 Smoke on the Section

Objective number		Capability verb(s)	Description of required performance and conditions under which it is to occur
1.	MG[3]	Recall Recognize	Origins, probable concentrations, and physiological effects of toxic gases and smoke resulting from an unknown source
2.	MG/EE	Assess Plan	Course of action for rapid evacuation from the face through heavy smoke
3.	MG/EE	Originate Plan Execute	Method of temporarily protecting a co-worker without a FSR or SCSR from heavy smoke by using available materials
4.	MG	Recall	Physical characteristics of hot air and smoke, especially their relative density
5.	EE	Identify Discriminate Plan	Escape routes through smoke to a safer area, given a map of a mine section
6.	EE/FA	Evaluate Select	Critical actions to minimize the risk of further injury to a roof fall victim and co-workers
7.	EE/FA	Recall Identify Discriminate Plan Execute	Proper steps and sequence for reporting a fire, accounting for all miners, effectively fighting the fire with available means, and treating an injury victim
8.	EE	Identify Discriminate	Probable factors contributing to a shuttle car cable fire and subsequent ignition of combustible materials and coal
9.	MG	Recall Discriminate	Physical and chemical characteristics and physiological effects of carbon monoxide

[3] Skill and knowledge domain abbreviations:
MG mine gases
EE emergency evacuation and escape
FA first aid

Master Answer Sheet for Smoke on the Section

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 make a selection. Otherwise you may not get the information you need.

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

1. [You shouldn't do this unless you plan to put it on now. Try again!]

2. [He's probably down at the feeder. You need to act now. Try again!]

3. [Correct! Carbon monoxide may be present. Do the next question.]

4. [This is very dangerous! You and Big Tim may die. Try again!]

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

5. [Correct! A "snap" decision could prove fatal to both of you. You are not yet in]
   [smoke. Do the next question.]

6. [This would be difficult to do, and you would likely become separated in the]
   [smoke. Try again!]

7. [There is a more critical first step. Try again!]

8. [Although "misery loves company," it is important that at least one of you is]
   [protected from carbon monoxide. Try again!]

9. [Should it be necessary for someone to get through the smoke quickly, it]
   [should be you rather than Tim. Try again!]

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

10. [The effects of carbon monoxide do not depend on physical condition. Try]
    [again!]

11. [This will not protect him from carbon monoxide. You still don't know the]
    [source or extent of the smoke. Try again!]

12. [Smoke is slowly drifting in toward the face. Tim would soon be overcome. Try]
    [again!]

13. [Correct! This is only a short-term solution, but should protect him until help]
    [can arrive. Do the next question.]

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

14. [Correct! Hot air and smoke tend to rise. Moving close to the face will buy more time. He should also try to remain calm.]

15. [Hot air and smoke will be thickest near the roof.]

16. [This will not make a difference.]

17. [Correct! This will provide a second "barricade" and double protection.]

18. [Absolutely not! This would cause leakage and place Tim in danger.]

19. [Correct! The water will help seal the brattice material and provide more protection from smoke and CO.]

Question E (Choose only ONE unless directed to "Try again!")

20. [You are in heavy, black smoke and can't see. Your FSR becomes very hot. You soon get disoriented. Try again!]

21. [You are in heavy, black smoke and can't see. Your FSR becomes very hot. You soon get disoriented. Try again!]

22. [You are in heavy, black smoke and can't see. Your FSR becomes very hot. You soon get disoriented. Try again!]

23. [Correct! By running your left hand around pillar a, you quickly get into fresh air through the check curtain in the crosscut between #1 and #2. Do the next question.]

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

24. [The fire may soon be out of control, but there is still a more critical first step. Try again!]

25. [Matt may need his FSR. But there is a more critical first step. Try again!]

26. [There is a more critical first step. Try again!]

27. [Correct! You yell to the face boss and two other miners near the stuck shuttle car. Do the next question.]

28. [It would be dangerous to go back for Tim now. There is a more critical first step. Try again!]

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

29. [Correct! The fire looks small. You have an adequate number of extinguishers and a good supply of rock dust.]

30. [Correct! The faceboss says that only Tim is missing. Everyone else is accounted for and now knows about the fire.]

31. [Correct! Management can help locate additional fire fighting supplies and may want to clear all miners not fighting the fire from the mine.]

32. [SCSRs are not intended for rescue. You should not search for Tim until the fire is extinguished and the smoke has cleared.]

33. [Correct! Only a quick survey of his condition was done earlier. He can now be treated for his injuries at a safe distance from the fire.]

34. [Correct! This probably was done by Matt before repairs were started, but it's a good idea to check anyway.]

35. [Correct! While the others are fighting the fire with rock dust and fire extinguishers, preparations to use water should be made. The fire may be larger than first suspected.]

36. [This would be difficult to do in smoke. A mistake could interfere with keeping those fighting the fire in fresh air.]

37. [This would endanger Tim and the mine. The miners and materials needed to fight the fire are available.]

38. [Correct! These may be needed to complete the job and to put out the oil fire.]

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

39. [This procedure is acceptable, providing the proper precautions are taken.]

40. [Correct! Matt should have sounded the top before beginning repairs and any loose rock should have been either taken down or bolted up.]

41. [Correct! Matt should have put rock dust on the oil or pulled more cable from the reel and changed position before using the torch.]

42. [Correct! This added fuel to the fire.]

43. [All trailing cables are made from flame-retardant material.]

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

44. [Correct! Blood has a 300 times greater preference for CO than for oxygen.]

45. [CO is odorless, colorless, and tasteless.]

46. [CO is almost the same density as air. Generally, it rises toward the top with]
[hot air and smoke.]

47. [Correct, but only in concentrations between 12.5 and 75%.]

48. [Correct!]

49. [Unconsciousness will occur in less than 30 minutes and death in less than an]
[hour in only 0.16% CO.]

50. [CO is extremely toxic, even in very low concentrations.]

51. [Correct! But no matter what it's called, it's still very dangerous, even in very]
[low concentrations.]

52. [Any irritation that comes from a fire is from smoke particles and not CO.]

Question J

End Of Problem

Finding your score

Number of "Correct" answers you colored in = (1) _____

30 minus number of incorrect answers you colored in = (2) _____

Add blanks one and two to get your total score = (3) _____

Highest possible score = 52

Lowest possible score = 0

Instructor's Discussion Notes for Smoke on the Section

Use the information presented here and on the master answer sheet, your own ideas and experience, and that 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 a mine 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 answers on 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 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. Don't read the notes to the class members. This would be boring and ineffective. Rather, 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 answer is 3. The most important thing to do at this time is to protect yourself from possible CO poisoning. A filter self-rescuer (FSR) should not be taken off your belt (1) until its ready to be used, which should be at the first sign of smoke. A miner in this situation should not wait for instructions (2), nor should he attempt escape without respiratory protection (4).

Question B - The correct answer is 5. Reaction to all emergencies requires careful deliberation, especially when emergency evacuation and escape is complicated by such conditions or circumstances as: blocked passages, unavailable or inoperative personal protective devices, unavailable or defective first aid supplies and materials, and the movement of physically or emotionally impaired victims. Sharing FSRs in a CO contaminated atmosphere (6) is ineffective. The source and extent of the smoke is unknown at this time, so maximum protection is advisable. Going across the section in heavy, black smoke (7) is dangerous because of the possibility of oxygen deficient air, for which the FSR is of no value. Further, it would be difficult, if not impossible, to see well enough to travel. Getting lost and disoriented is likely. Offering your FSR to a co-worker (9) is a noble gesture, but if someone must go for help, it should be the more agile of the two. Also, the life of a FSR in a CO rich atmosphere is directly proportional to the air exchange volume of the wearer, which would be lower for the more physically fit miner. Waiting for help with Big Tim might comfort him (8), but it could result in the death of both miners. There have been many instances of CO deaths in mine fires where the seals on the victims' FSR units were never broken. Whenever smoke is present, CO should be suspected!

Question C - The correct answer is 13. If this were a gassy mine, this might not be the best action. It is clear however, that immediate escape for Tim involves travel through smoke without a FSR and should not be attempted. A seal across the entry should direct enough of the smoke away from the face area of the #1 entry to keep the CO at a relative low level until help can arrive. Again, the miner should not offer his FSR to Tim (10) for the same reason discussed in Question B. Although a damp rag (11) can protect the eyes, nose, and throat from some of the irritants in heavy smoke, it offers no protection from CO. To have Tim remain in the #1 face without the curtain in place (12) could prove fatal. The smoke may soon drift into all available space.

Question D - The correct answers are 14, 17, and 19. The density of CO relative to air (1.00) is 0.9672. Thus, for all practical purposes, the density of air and CO are the same. When the air is moving, CO is likely to mix with it and not rise above it. Smoke and hot air from a fire (often CO rich) however, is much less dense than cool air, and therefore rises. The air along the bottom tends to be cleaner and cooler. Tim should position himself near the mine floor as far away from the smoke cloud as possible (14). He can provide added protection from smoke and CO by placing a second line brattice across the entry inby the first one (17). Wetting the brattices with the wash down hose is an excellent idea. The water will seal the pores in the brattice material and make the seals much more smoke resistant. It is doubtful that anyone will select 18, but how many in your class would probably do this if confronted with this situation? Anxiety and curiosity invite this action, as miners would look for cap lamps of rescuers and the status of the smoke cloud.

Question E - The correct answer is 23. This route minimizes the CO exposure. Route A takes you directly toward the fire, where smoke would be the heaviest. Not only will the CO concentration be highest with the choice of this path, but there is the risk of oxygen deficiency. It would also be very difficult to travel without becoming disoriented. Route B also takes you into heavy smoke, through which travel would be difficult. There is also still the risk of oxygen deficiency. There is no good reason for selecting Route C. This would prolong exposure to what is almost assuredly a CO rich and oxygen deficient atmosphere. All routes except D are too long and roundabout or require traveling in heavy smoke. Route D helps the miner find his way quickly to neutral air, which is likely to be smoke free (although by no means certain). The straight path across the last open crosscut just outside the #1 face will put the miner in contact with pillar a. (See Figure 2.) He or she can then follow the rib line by keeping his left hand in contact with the pillar. This question provides you with a good opportunity to discuss the capabilities, limitations, and use of FSRs.

Question F - The correct answer is 27. Once the fire is discovered, help should be obtained to fight it. Miners should be aware of the likely location of others in their crew, should rapid communication be required. To randomly hunt for crew members in a large area, such as one created by a super section, wastes valuable time. By remembering the location of the shuttle car stuck by the feeder, the miner in this question was able to quickly find help. To fight the fire alone is ill-advised. Should a single miner fighting a fire be overcome or be unable to extinguish it, others could be injured. Once the fire is discovered, it should be reported immediately. To return for Tim would place everyone on the section in danger and could allow the fire to grow. A quick primary survey of

Matt's condition revealed no life threatening injuries. He is conscious and able to talk. To treat him while the fire is growing would endanger everyone on the section.

Question G - The correct answers are 29, 30, 31, 33, 34, 35, and 38. Before any further action is taken, all miners should be accounted for and removed from danger (30). The fire is relatively small, but can soon become a major threat. Enough miners and equipment are available to fight the fire and this action should be given priority (29). It is also important to report the fire to management right away so they can call a mine rescue team to stand by and notify the proper state and federal authorities (31). While these tasks are going on, Matt can be given first-aid treatment in a safe place (33). (You might discuss how Matt should have been treated when discovered if: 1) his injuries were more severe, 2) his clothing was on fire, or 3) he had a suspected spinal injury.) In this problem, the availability of rock dust, fire extinguishers, and several miners make fighting the fire with these class B agents the fastest and best option. It takes much longer to disconnect and move a high pressure water hose. However, it is wise to send two miners to begin preparing a water line to fight the fire, should that become necessary (35). Search and rescue are functions of mine rescue and should not be attempted without proper equipment. FSRs and SCSRs should not be used for this purpose (32). If the fire is fought promptly and well, and if Tim properly protects himself from the smoke, he will be 0. K. and can be rescued by miners traveling in fresh air.

The power to the shuttle car with the damaged cable is probably off. Otherwise Matt should not have been splicing the cable (30 CFR 75.511). But there are plenty of miners on the section. It would be a good idea to send one of them to make sure the power is off (34). Short circuiting the air would not be a good idea (36). The ventilation should not be disturbed. In addition to violating 30 CFR 75.322, this action could confuse others on the section who might already be attempting to escape. Also, to successfully short-circuit the air would require several changes in the face ventilation, as shown on Figure 4 on the next page. Such changes would be difficult to make under stressful conditions and in heavy smoke. To make a mistake could contaminate all air on the section and interfere with fighting the fire. Such ventilation changes would also waste precious time during which the fire might get out of control. Regulating the air by hanging a curtain across #1 (return) could slow the fire's spread, but most experts agree that this should not be tried unless the fire starts getting out of control. The fire, as described, is still controllable. It would be improper and unethical for all the miners to leave the section at this time (37). The situation is dangerous but not yet life threatening. You might discuss how the answer to this question can change if the mine were gassy or if an explosion occurred. It would be a good idea to send a miner for more rock dust and fire extinguishers (38). These may be needed later.

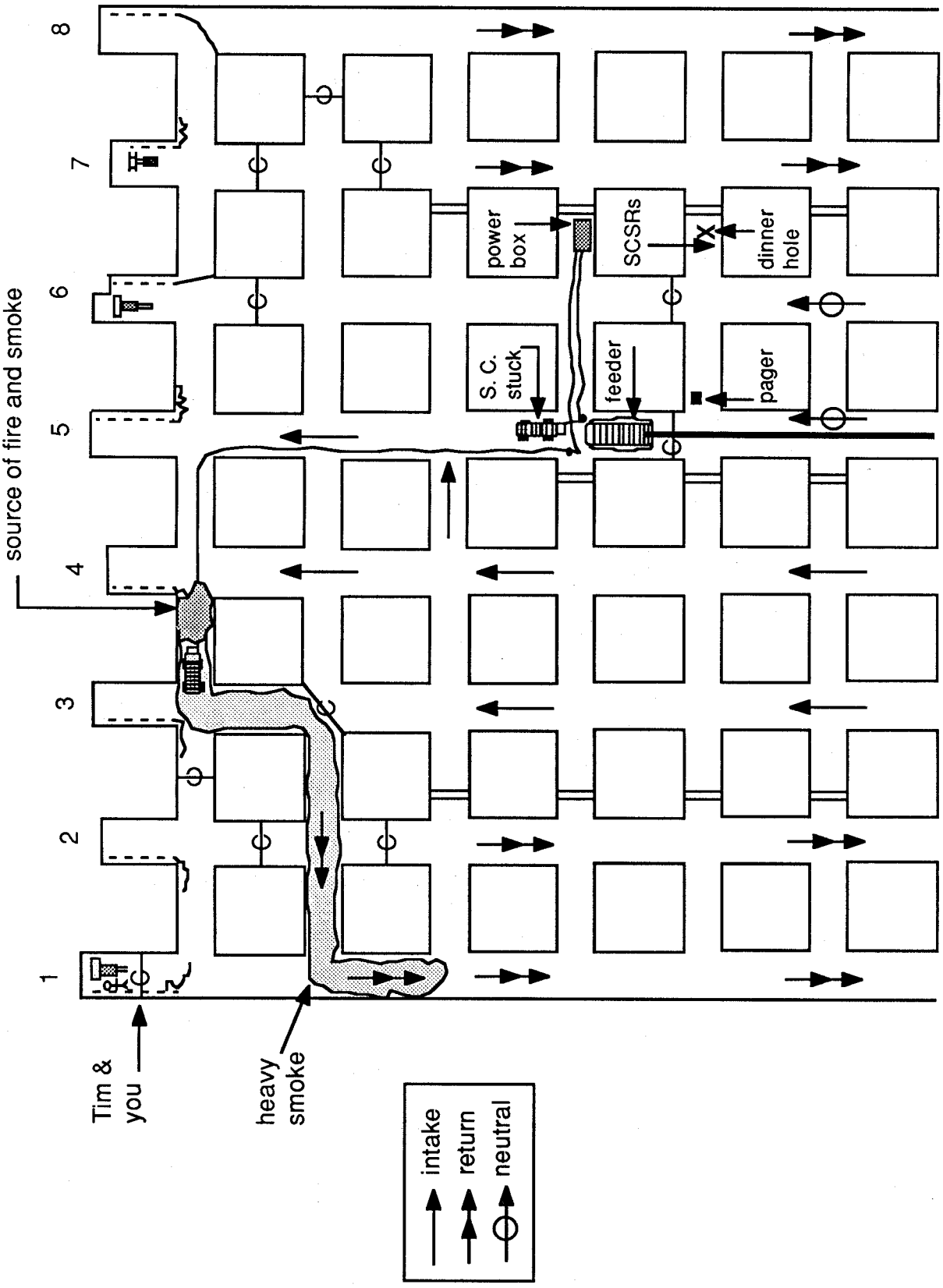

Figure 4: Ventilation changes required to short-circuit the smoke to help protect Tim

Question H - The correct answers are 40, 41, and 42. Repairmen should be reminded to pay attention to roof conditions where they are required to work (40) and should practice good housekeeping, especially when a heat source is to be used (41 and 42). If hot splices are preferred over cold ones (tape, tape and sleeve, and expanded sleeve), special precautions should be taken to prevent fire and explosion (39). If open flames are necessary for repair work in or inby the last open crosscut, a methane test should be made and fire fighting equipment should be brought to the work site before repairs are began. One manufacturer of splice kits supplies flameless chemical sources of heat to shrink and seal the splice boot. All trailing cables are flame-retardant (43) in accordance with 30 CFR 75.600.

Question I - The correct answers are 44, 47, 48, and 51. Although explosive at high concentrations, the property that makes CO so dangerous is it's extreme toxicity. It has no distinguishing physical properties, thus making it difficult to detect. "White damp" is about the same density as air, and is a natural product of combustion. CO acts as an asphyxiant by displacing the oxygen normally carried by the hemoglobin of the blood. The affinity of the blood for CO is about 300 times that for oxygen. At a concentration as low as 0.10%, loss of some mental function can occur within 45 minutes; collapse, unconsciousness, and coma can occur within 1 hour; and death can occur only 30 minutes later. By comparison, you might point out that 0.1% concentration is 50 times less than the concentration of the lower explosive limit for methane (5%). Figure 5 on the next page gives values of CO that are disabling at various concentrations and times.

Question J - Ask your class members if they found any other errors of judgment, or violations of rules and procedures other than:

- Big Tim leaving his FSR on a piece of equipment far away

- An accumulation of loose coal and dust in the last open crosscut

- Matt’s failure to inspect the top before he made the splice

- Failure to clean up the oil spill near the shuttle car with the damaged cable

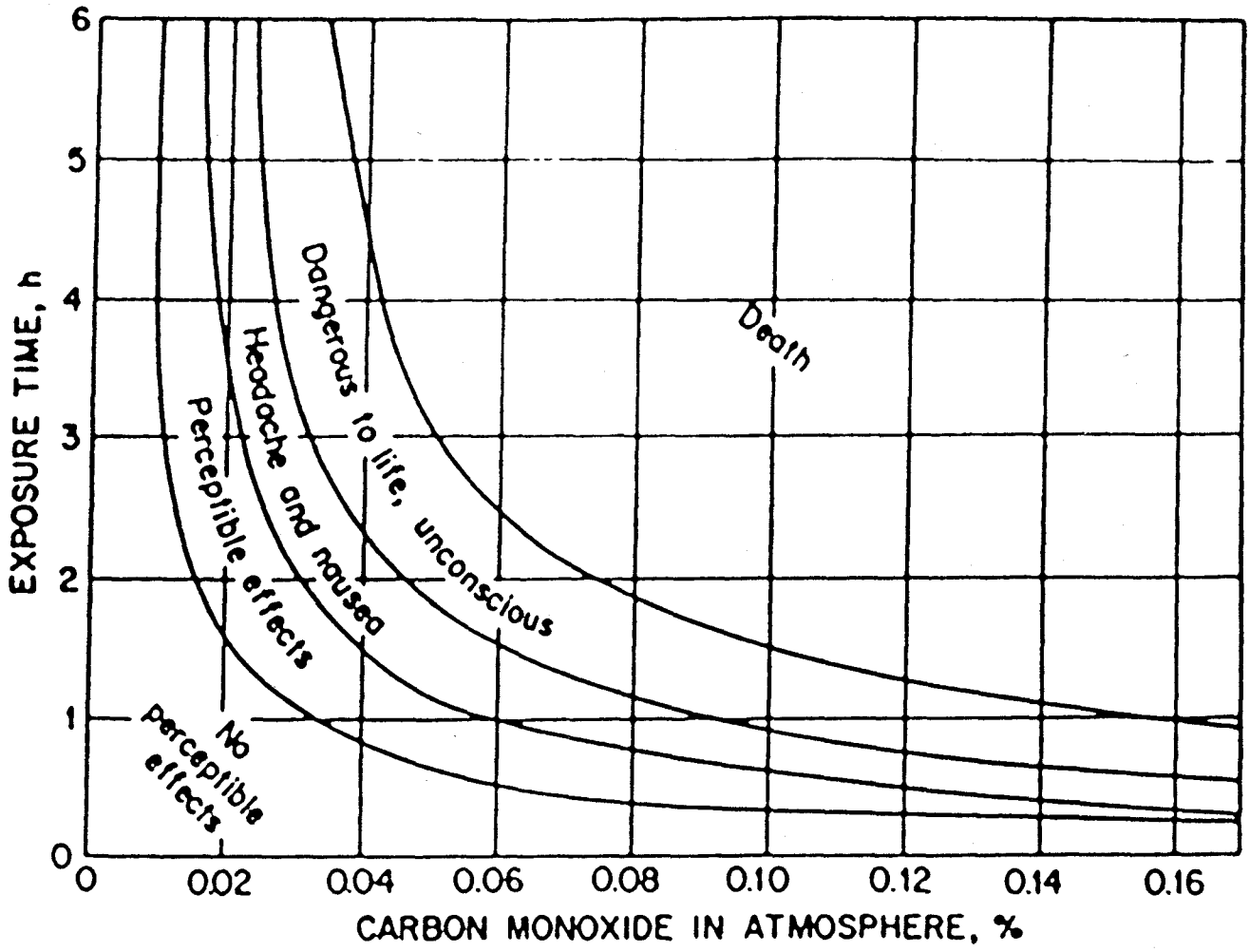

Figure 5: Toxicity of carbon monoxide as a function of concentration and time. (Hartman, Mutmansky, & Wang 1982.)

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Scoring Key for Smoke on the Section

The correct answers are marked with an asterisk.[4]

Question	Answer Number					
A	1	2	3*	4		
B	5*	6	7	8	9	
C	10	11	12	13*		
D	14*	15	16	17*	18	19*
E	20	21	22	23*		
F	24	25	26	27*	28	
G	29*	30*	31*	32	33*	34*
	35*	36	37	38*		
H	39	40*	41*	42*	43	
I	44*	45	46	47*	48*	49
	50	51*	52			

[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 NIOSH, Pittsburgh Research Laboratory, Pittsburgh, PA phone 412-386-5901, fax 412-386-5902 or email to minetraining@cdc.gov.

Smoke on the Section

Problem Booklet

Instructions

Read the problem situation described on the next page. Study the map until you understand the location of the miners and equipment in the problem. Next, answer each of the 10 questions. Do them one at a time. Don't jump ahead, but you may look back to earlier questions and answers. For most of the questions, choose only one answer unless you are told to "Try again!". A few questions ask you to select as many answers as you think are correct. Follow the instructions for each question.

After you have selected a choice to a question, look up its number on the answer sheet. Select your answer 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

The mine, which is above the water table, is wet and has a 52 inch seam.

This is an 8 entry super section, with 2 continuous miners, and 2 shuttle cars.

You (Cecil) are a continuous miner operator on the West Mains Section.

You are slim, strong, and in good shape (5' 10" and 145 lbs). Big Tim, your helper, is overweight and in poor physical condition (6' 2" and 275 lbs.).

The shuttle car roadway is littered with a large accumulation of loose coal and coal dust.

Problem

You and Big Tim have just trammed the continuous miner to the face of the #1 entry. Your boss comes by and tells you that one shuttle car with a damaged cable is stalled between #3 and #4 in the last open crosscut, and the other is stuck near the feeder. You and Big Tim decide to replace a few worn bits while waiting. While pulling the bits, you smell something burning. Tim tells you the smell is probably just from heat shrinking the boot over the splice on the shuttle car cable. After installing the bits, you go to the mouth of the #1 entry to establish face ventilation. Your eyes begin to burn and water. You look down #1 and across to #2 and see a cloud of thick, black smoke. The smoke is going by the mouth of #1 and out the return. You immediately yell to Tim and tell him about the smoke. After studying the map on the next page, turn the page and answer the first question.

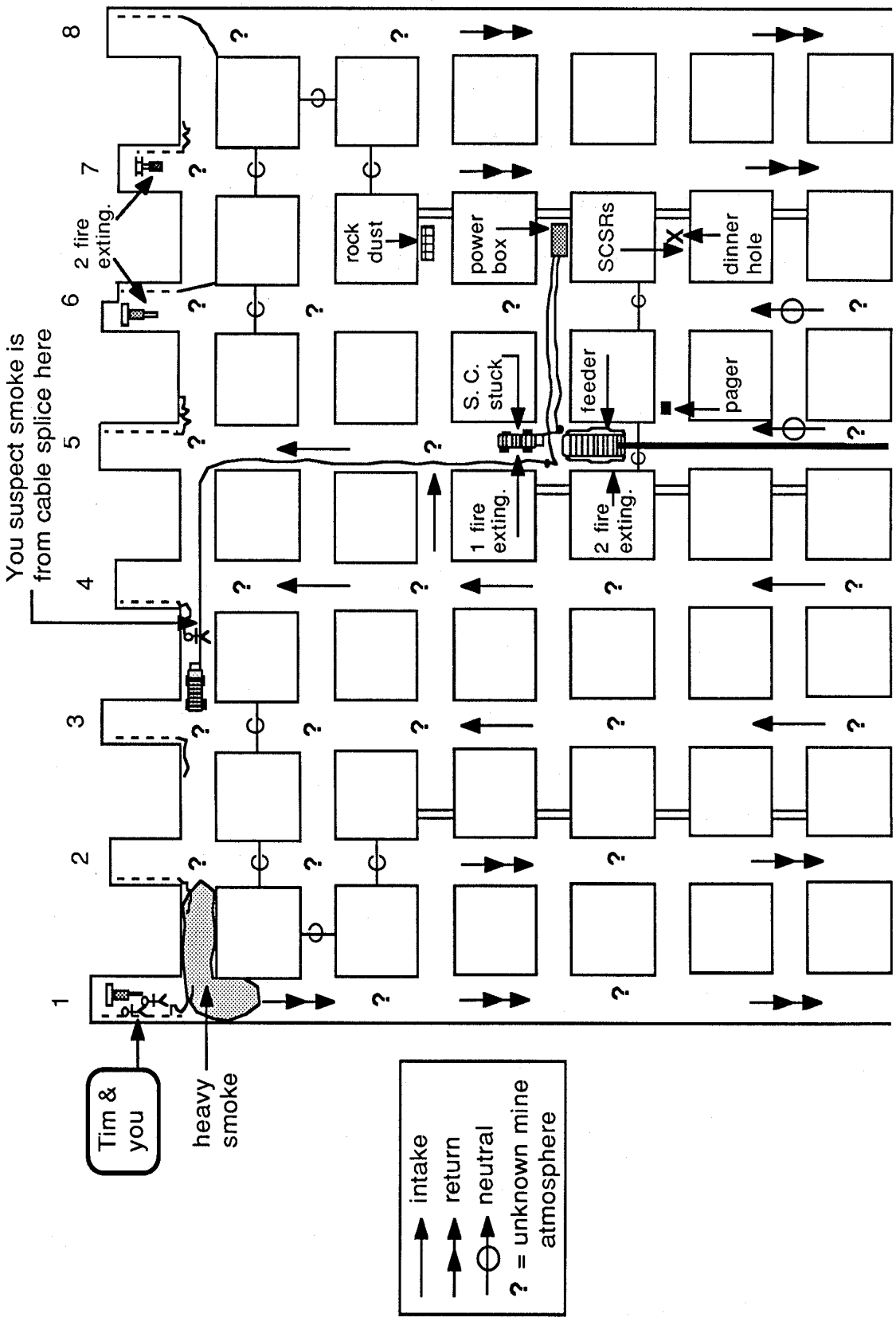


Figure 1: Your and Tim's position on the section, with the smoke cloud you can see and the possible locations of smoke marked with question marks

Question A

After telling Tim about the smoke, what should you do first? (Choose only ONE unless you are told "Try again!")

1. Take your filter self-rescuer off your belt and have it ready in case you need it.

2. Sit down and wait for instructions from your face boss.

3. Put on your filter self-rescuer and tell Tim to do the same.

4. Take a deep breath and head for intake air quickly.

Question B

As you are putting on your filter self-rescuer (FSR), Big Tim tells you that he has left his FSR on the other miner, which is broken down in the #6 entry. What would you do now? (Choose only ONE unless you are told to "Try again!")

5. Finish putting on your FSR, but stop and think before taking further action.

6. Share your FSR with Tim by taking turns breathing through it, and dash through the smoke.

7. Tell Tim to stay put. Finish putting on your FSR and go across the section to get Tim's FSR.

8. Leave your FSR off and wait for help with Tim.

9. Offer your FSR to Big Tim and have him go for help.

Question C

Smoke is slowly drifting toward the #1 face where you and Tim were working. You must act quickly. What would be the best thing for you to do now? (Choose only ONE unless you are told to "Try again!")

10. Give Tim your FSR. You're in better physical condition than he is. You can take more smoke than he can.

11. Have Tim put a damp rag over his nose and mouth. Lead him through the smoke to fresh air.

12. Leave Tim in the entry while you go through the smoke for help.

13. Drag the line curtain at the mouth of #1 to Tim. Have him hang it across the entry near the end of the miner boom and stay behind it. You go for help.

Question D

To limit his exposure to smoke and carbon monoxide (CO), what should Tim do as he waits for help? (Select as MANY as you think are correct.)

14. Stay as near the floor and as close to the face as is safely possible.

15. Climb on top of the miner to get above the smoke.

16. Stay next to the rib.

17. Hang a second line brattice just inby the first one.

18. Stay near the curtain(s). Lift the curtain(s) often to check for smoke.

19. Use the wash down hose to spray the curtain(s).

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

Question E

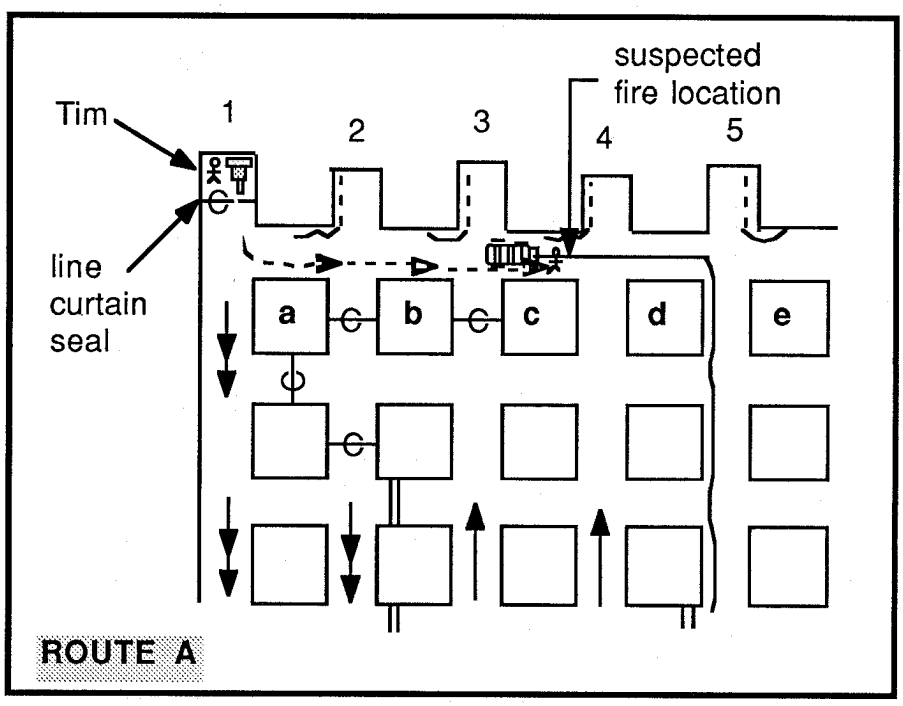
As you step into the smoke to go for help, your eyes begin to burn and water. Look at Figure 2 on the next two pages. Which path would you take? (Choose only ONE unless you are told to "Try again!")

20. Route A

21. Route B

22. Route C

23. Route D



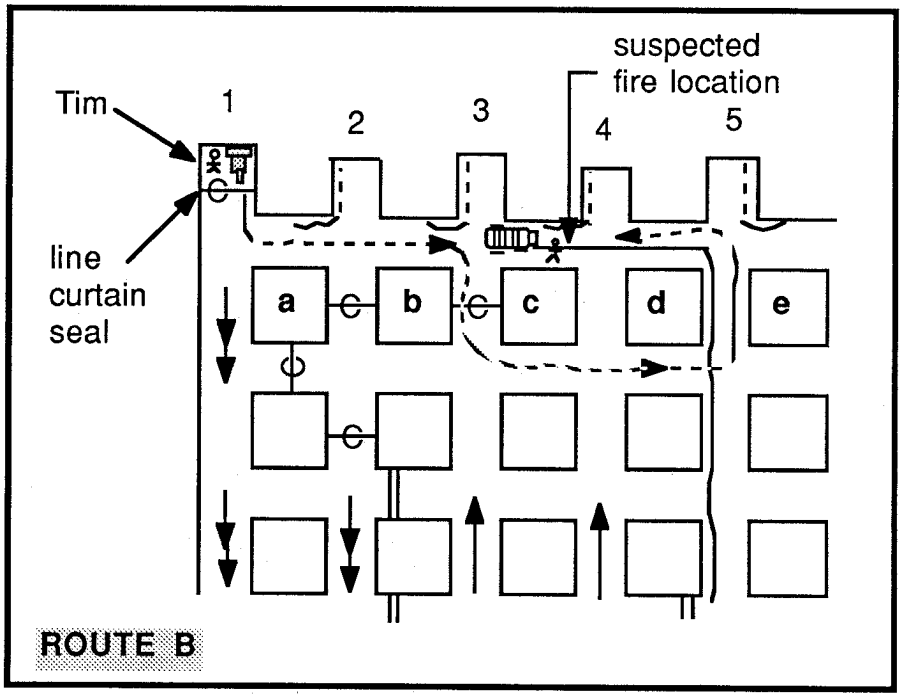
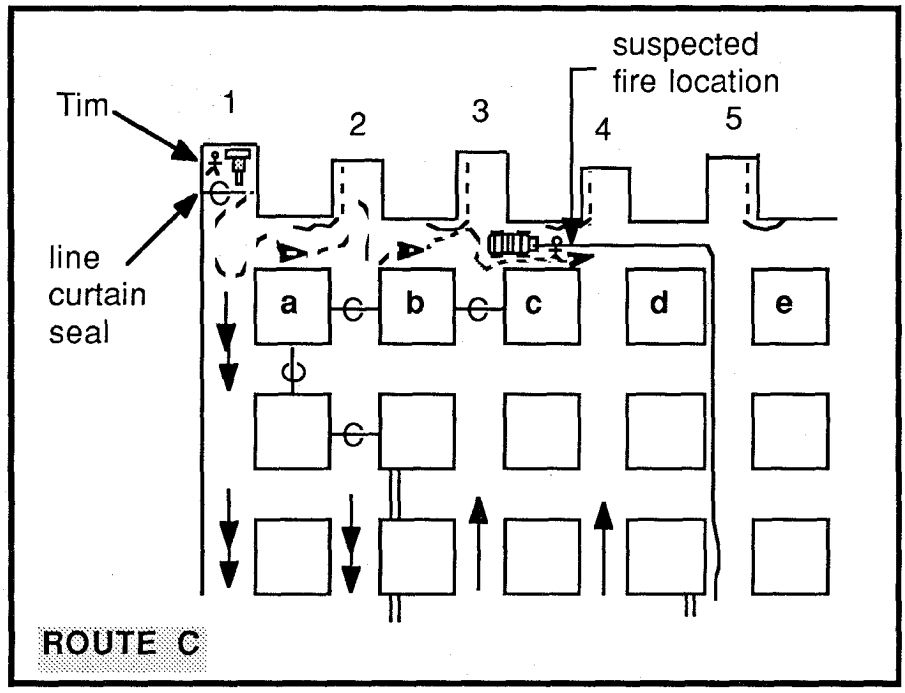


Figure 2: Four alternative routes



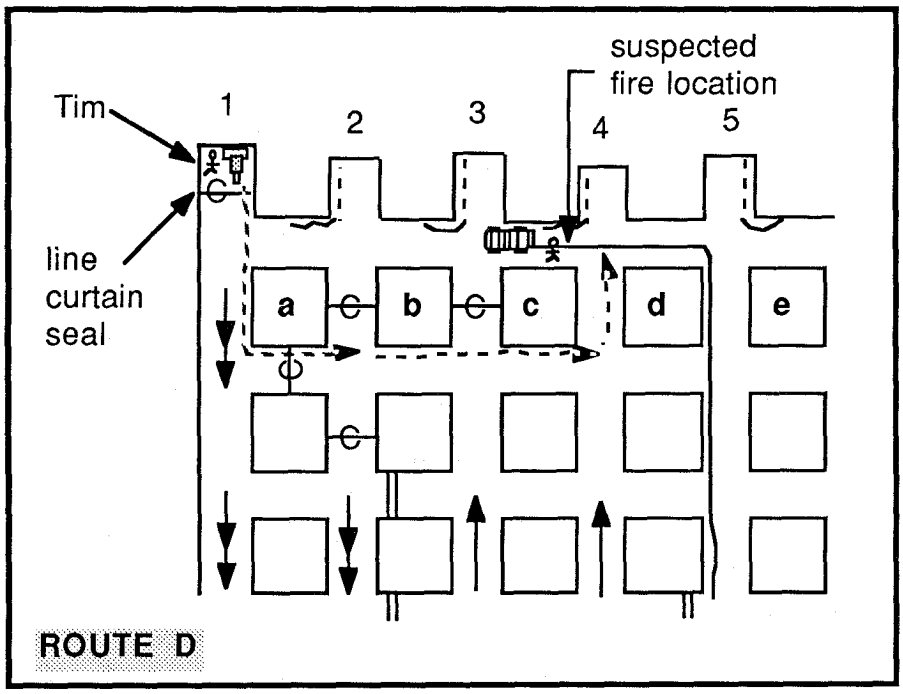


Figure 2: (continued)

Question F

As you look up the #4 entry (see Figure 3 on the next page) on your way for help, you see a fire. You continue along the pathway shown in Route D in Figure 2 on page 10. You see Matt Mitchell, the repairman, lying on his back on the fresh air side of the fire. His hard hat is off and is lying beside a slab of roof rock. A propane torch lies burning in a large puddle of hydraulic oil, caused by a burst roof bolter hose. The oil, cable, loose coal, and the rib are burning. The fire looks fairly small, but you .can't be sure. The smoke blocks your view. You quickly examine Matt. As you do, he comes to and tells you he's OK. Matt has a large lump and small laceration on his forehead. His arm is crooked. Using a clothing drag you pull him a safe distance from the fire. At this point, what would you do? (Choose only ONE unless you are told to "Try again!")

24. Fight the fire.

25. Take Matt's FSR and go back to give it to Tim so he can escape to fresh air.

26. Begin treating Matt's injuries.

27. Go toward the dinner hole for help.

28. Leave Matt and get Tim's FSR off the miner in the #6 entry.

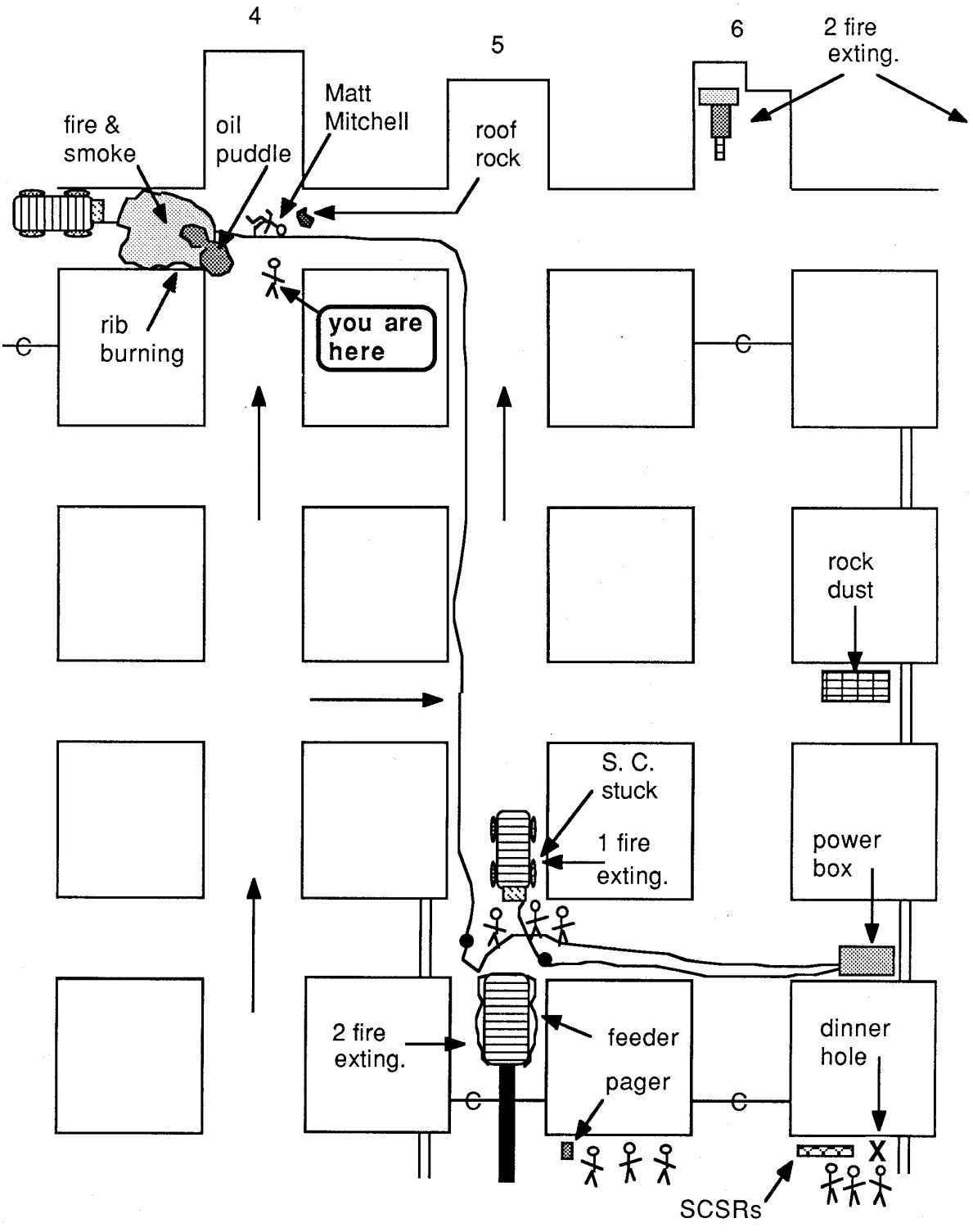


Figure 3 Location of fire, Matt, and you

Question G

You tell the section foreman what you've seen and done. What should he do now? (Select as MANY as you think are correct.)

29. Tell four of you to grab fire extinguishers and rock dust and go fight the fire.

30. Account for all crew members.

31. Send one miner to call outside and report the fire.

32. Tell two of you to put on SCSRs, take one with you, and go for Tim.

33. Send someone to give first-aid to Matt.

34. Send one miner to check to see that the power to the shuttle car whose cable is on fire has been knocked.

35. Send two miners to start taking apart the water line to the continuous miner in #6, and getting a hose ready to attack the fire with water from the fresh air side, in case this becomes necessary.

36. Tell two miners to short-circuit the air and direct the smoke away from the #1 face where Tim is waiting for help.

37. Send all of you to the dinner hole, to meet up with the others, and exit the mine.

38. Send one miner to get extra fire extinguishers and rock dust.

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

Question H

You get the fire out. The air soon clears. You go over to #1 entry in fresh air. Big Tim is fine. He says his double, wet line brattices kept out the smoke. Your quick thinking and actions saved him and the mine section from harm. Big Tim says from now on he is going to carry his FSR.

Now think about the whole problem. What do you think were the major errors that contributed to this fire? (Select as MANY as you think are correct.)

39. Using a propane torch to help make a splice.

40. Matt's failure to check the top at the place he was working.

41. Failure to clean up the puddle of hydraulic oil from the roof bolter.

42. Allowing excess loose coal and coal dust to accumulate.

43. Using a flammable trailing cable.

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

Question I

The poisonous gas in this problem was carbon monoxide (CO). Which of the following statement(s) about CO are true? (Select as MANY as you think are correct.)

44. CO displaces the oxygen normally carried by the hemoglobin of the blood.

45. CO has an acid taste in high concentrations.

46. CO is slightly heavier than air and therefore is found next to the floor.

47. CO is explosive.

48. CO is produced by combustion (e.g., by mine fires and explosions, blasting, smoldering materials, and internal combustion engines).

49. You can survive approximately 90 minutes in a concentration of 0.5% CO.

50. CO is not toxic.

51. CO is sometimes called "white damp."

52. CO will irritate eyes, nose, and throat at high concentrations.

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

Question J

List all the violations of state and federal laws and your company rules that you can find in this 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 30. Write the difference in the second blank on the answer sheet.

3. Add the numbers on the first and second blanks. This is your score.

The best possible score of 52 results from selecting all the correct answers and no wrong answers. The worst possible score of zero results from selecting all the wrong answers and no correct answers.

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 NIOSH, Pittsburgh Research Laboratory, Pittsburgh, PA phone 412-386-5901, fax 412-386-5902 or email to minetraining@cdc.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. These may be obtained from the A. B. Dick Company, P.O. Box 1970, Rochester, New York 14692, phone 1-800-225-4835.

Answer Sheet for Smoke on the Section

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 make a selection. Otherwise you may not get the information you need.

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

1. [ ]

2. [ ]

3. [ ]

4. [ ]

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

5. [ ]
   [ ]

6. [ ]
   [ ]

7. [ ]

8. [ ]
   [ ]

9. [ ]
   [ ]

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

10. [ ]
    [ ]

11. [ ]
    [ ]

12. [ ]
    [ ]

13. [ ]
    [ ]

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

14. [ ]
    [ ]

15. [ ]

16. [ ]

17. [ ]

18. [ ]

19. [ ]
    [ ]

Question E (Choose only ONE unless directed to "Try again!")

20. [ ]
    [ ]

21. [ ]
    [ ]

22. [ ]
    [ ]

23. [ ]
    [ ]
    [ ]

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

24. [ ]
    [ ]

25. [ ]

26. [ ]

27. [ ]
    [ ]

28. [ ]
    [ ]

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

29. [ ]
    [ ]

30. [ ]
    [ ]

31. [ ]
    [ ]

32. [ ]
    [ ]

33. [ ]
    [ ]

34. [ ]
    [ ]

35. [ ]
    [ ]
    [ ]

36. [ ]
    [ ]

37. [ ]
    [ ]

38. [ ]

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

39. [ ]

40. [ ]
    [ ]

41. [ ]
    [ ]

42. [ ]

43. [ ]

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

44. [ ]

45. [ ]

46. [ ]
    [ ]

47. [ ]

48. [ ]

49. [ ]
    [ ]

50. [ ]

51. [ ]
    [ ]

52. [ ]

Question J

End Of Problem

Finding your score

Number of "Correct" answers you colored in = (1) _____

30 minus number of incorrect answers you colored in = (2) _____

Add blanks one and two to get your total score = (3) _____

Highest possible score = 52

Lowest possible score = 0

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.

You shouldn't do this unless you plan to put it on now. Try again!

He's probably down at the feeder. You need to act now. Try again!

Correct! Carbon monoxide may be present. Do the next question.

This is very dangerous! You and Big Tim may die. Try again!

Correct! A "snap" decision could prove fatal to both of you. You are not yet in smoke. Do the next question.

This would be difficult to do, and you would likely become separated in the smoke. Try again!

There is a more critical first step. Try again!

Although "misery loves company," it is important that at least one of you is protected from carbon monoxide. Try again!

Should it be necessary for someone to get through the smoke quickly, it should be you rather than Tim. Try again!

The effects of carbon monoxide do not depend on physical condition. Try again!

This will not protect him from carbon monoxide. You still don't know the source or extent of the smoke. Try again!

Smoke is slowly drifting in toward the face. Tim would soon be overcome. Try again!

Correct! This is only a short-term solution, but should protect him until help can arrive. Do the next question.

Correct! Hot air and smoke tend to rise. Moving close to the face will buy more time. He should also try to remain calm.

Hot air and smoke will be thickest near the roof.

This will not make a difference.

Correct! This will provide a second "barricade" and double protection.

Absolutely not! This would cause leakage and place Tim in danger.

Correct! The water will help seal the brattice material and provide more protection from smoke and CO.

You are in heavy, black smoke and can't see. Your FSR becomes very hot. You soon get disoriented. Try again!

You are in heavy, black smoke and can't see. Your FSR becomes very hot. You soon get disoriented. Try again!

You are in heavy, black smoke and can't see. Your FSR becomes very hot. You soon get disoriented. Try again!

Correct! By running your left hand around pillar a, you quickly get into fresh air through the check curtain in the crosscut between #1 and #2. Do the next question.

The fire may soon be out of control, but there is still a more critical first step. Try again!

Matt may need his FSR. But there is a more critical first step. Try again!

There is a more critical first step. Try again!

Correct! You yell to the face boss and two other miners near the stuck shuttle car. Do the next question.

It would be dangerous to go back for Tim now. There is a more critical first step. Try again!

Correct! The fire looks small. You have an adequate number of extinguishers and a good supply of rock dust.

Correct! The faceboss says that only Tim is missing. Everyone else is accounted for and now knows about the fire.

Correct! Management can help locate additional fire fighting supplies and may want to clear all miners not fighting the fire from the mine.

SCSRs are not intended for rescue. You should not search for Tim until the fire is extinguished and the smoke has cleared.

Correct! Only a quick survey of his condition was done earlier. He can now be treated for his injuries at a safe distance from the fire.

Correct! This probably was done by Matt before repairs were started, but it's a good idea to check anyway.

Correct! While the others are fighting the fire with rock dust and fire extinguishers, preparations to use water should be made. The fire may be larger than first suspected.

This would be difficult to do in smoke. A mistake could interfere with keeping those fighting the fire in fresh air.

This would endanger Tim and the mine. The miners and materials needed to fight the fire are available.

Correct! These may be needed to complete the job and to put out the oil fire.

This procedure is acceptable, providing the proper precautions are taken.

Correct! Matt should have sounded the top before beginning repairs and any loose rock should have been either taken down or bolted up.

Correct! Matt should have put rock dust on the oil or pulled more cable from the reel and changed position before using the torch.

Correct! This added fuel to the fire.

All trailing cables are made from flame-retardant material.

Correct! Blood has a 300 times greater preference for CO than for oxygen.

CO is odorless, colorless, and tasteless.

CO is almost the same density as air. Generally, it rises toward the top with hot air and smoke.

Correct, but only in concentrations between 12.5 and 75%.

Correct!

Unconsciousness will occur in less than 30 minutes and death in less than an hour in only 0.16% CO.

CO is extremely toxic, even in very low concentrations.

Correct! But no matter what it's called, it's still very dangerous, even in very low concentrations.

Any irritation that comes from a fire is from smoke particles and not CO.