

# **Lingering Smoke Exercise**

## **Instructor's Copy**

Behavioral Research Aspects of Safety and  
Health Group (BRASH)  
Institute for Mining and Minerals Research (IMMR)  
University of Kentucky, Lexington, Kentucky<sup>1</sup>

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<sup>1</sup> 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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## 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 blank. Copies of this answer sheet must have the invisible ink answers that appear in Appendix C printed on them<sup>2</sup>. Answer sheets are consumable. One is needed for each person or each small group of 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>Length:</u>	Nine questions (25 minutes for administration plus 30 for discussion)
<u>Skills:</u>	Mine ventilation basics Recognizing symptoms for CO poisoning Proper procedures for ventilation of blasting gases from mine faces Safe rescue operations for assisting downed victims in bad air without endangering one's own life
<u>Location:</u>	Underground
<u>Problem:</u>	You are a scoop operator. During the first part of the shift an entry was shot and partly loaded. Two miners have complained that they were dizzy and sick to their stomach. Otherwise the shift has gone on as usual. You reenter the mine after lunch and notice that some smoke is still hanging. You are worried the ventilation may not be adequate. Soon two miners at the face go down. You must decide what to do to help them.

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<sup>2</sup> 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](mailto: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 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 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 Lingering Smoke Exercise

Objective number	Capability verbs	Description of required performance and conditions under which it is to occur
1. MG <sup>3</sup>	Recognize	Potential danger that exists when smoke hangs after shots have been fired
2. EE	Assess Plan	Course of action for recovering an unconscious victim from a mine entry with a potentially lethal atmosphere.
3. EE	Evaluate Select	Actions which should be taken for assisting multiple victims who have been overcome by toxic mine gasses when only one rescuer is at the scene
4. MG	Evaluate	Rapid, safe methods for ventilating a mine entry
5. MG/EE	Recognize Plan Execute	Safe rescue operations for assisting victims in bad air.
6. MG	Recall Recognize	Importance of proper pre-shift and on-shift examinations
7. MG	Recall Recognize	Symptoms of CO poisoning

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<sup>3</sup> Skill and knowledge domain abbreviations:  
 EE = Emergency evacuation and escape  
 MG = Mine Gases

## Master Answer Sheet for Lingering Smoke Exercise

Use this answer sheet to mark your selections. Rub the special 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. [ The assistant foreman tells you to go load entry 3 like you're supposed to. ]  
[ Try again! ]
2. [ Correct! The assistant foreman tells you that he will take care of it later. Do ]  
[ the next question. ]
3. [ There is something else that you should do now. Try again! ]
4. [ Entry 3 doesn't need a curtain for ventilation. Try again! ]

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

5. [ There is something you should do first. Try again! ]
6. [ There is something you should do first. Try again! ]
7. [ This is not the best thing for you to do. Try again! ]
8. [ Correct! Do the next question. ]

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

9. [ This will put you and Speedy in danger. Try again! ]
10. [ This is not the best thing to do now. Try again! ]
11. [ Correct! You go to entry 5 and tell the assistant foreman that Chester is ]  
[ down. Do the next question. ]
12. [ This will put you in danger. Anyway, this is not the time to argue with ]  
[ Speedy. Try again! ]

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

- 13. [ Soon all of you are down and no one is left to help you. Try again! ]
- 14. [ This will put you in danger. Try again! ]
- 15. [ Correct! The assistant foreman keeps moving toward the face. You tram your  
[ scoop to entries 1 and 2 and pick them up. Do the next question. ]
- 16. [ Although this is a tough decision to make, SCSR's are to be used only for  
[ escape... not for rescue. Try again! ]

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

- 17. [ Correct! This is the safest option. Do the next question. ]
- 18. [ This is not possible. You would be overcome. Try again! ]
- 19. [ SCSR's are not to be used for rescue. Try again! ]
- 20. [ By the time they arrive, it will be too late to help the victims. Try again! ]

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

- 21. [ This will not ventilate entry 4. Try again! ]
- 22. [ This is not the best way to ventilate entry 4. Try again! ]
- 23. [ This is not the best way to ventilate entry 4. Try again! ]
- 24. [ Correct! This is the best way to ventilate entry 4. Do the next question. ]

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

- 25. [ This is not the best thing to do. Try again! ]
- 26. [ There may not be enough time to wait for the rescue team. Try again! ]
- 27. [ Correct! Do the next question. ]
- 28. [ This is not the best thing to do. Try again! ]

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

29. [ Correct! The ventilation as shown on Figure 1 was not adequate. This should ]  
[ have been noted during the preshift examination and corrected. ]
30. [ A flame safety lamp will not tell you when small but deadly levels of CO are ]  
[ present. ]
31. [ Correct! ]  
[ ]
32. [ Equipment should not be taken into the working face until a methane test is ]  
[ made. ]
33. [ Correct! Miners should know symptoms of CO poisoning, of poisoning from ]  
[ other mine gases, and of oxygen deficiency. ]

**Question I**

END OF PROBLEM

**Finding your score**

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

23 minus the number of incorrect answers you colored in = (2) \_\_\_\_\_

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

Highest possible score = 33

Lowest possible score = 0



## Instructor's Discussion Notes for Lingering Smoke Exercise

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 2. A curtain should be hung so that the smoke will clear. Entry 3 is not yet large enough to need a curtain. This is a good place to discuss why miners should not assume that someone else will take care of a problem that they recognize. They should report the problem or correct it before continuing with their work.

**Question B** - The correct answer is 8. This should be done so that the assistant foreman will know that there is a problem and so that he can help. Telephoning outside is important, but it is faster to get help from other miners on the section if possible. This is a good point to discuss whether or not a miner should enter a place if only one miner is down.

**Question C** - The correct answer is 11. Choices 9 and 12 both put rescuers in danger. Restoring ventilation is important, but more help should be found first.

**Question D** - The correct answer is 15. With 2 miners down and another in trouble, more than one rescuer will be needed. It is most important that miners realize that they should not place themselves in danger while trying to help their co-workers. If a would-be rescuer goes down, all the other miners may die because no one will be able to get help.

**Question E** - The correct answer is 17. The safest way to help the victims is to get good air into the entry as soon as possible. It would probably be impossible for the miners to

hold their breath and drag the men to good air. They would likely be overcome. The victims will not survive if nothing is done until a mine rescue team can arrive.

Whether or not SCSRs should be used in these situations is a point that is strongly debated by many miners. They are designed to be used only for self rescue and escape and are approved only for that purpose.

**Question F** - The correct answer is 24. More curtains than are necessary are hung in option 23. This would waste time. Option 22 would ventilate the entry, but 24 allows the rescuers to advance with good air at their backs. The blowing system in option 24 would also be more effective in moving clean air to the downed miners than would the exhausting system.

**Question G** - The correct answer is 27. Time is an important consideration at this point. There may not be time to wait for a mine rescue team or for more equipment. Staying between the rib and the curtain, as it is shown in answer 24 will allow the miners to advance into the entry while staying in good air. Getting good air to the unconscious miners by using a blowing curtain arrangement can save their lives.

**Question H** - The correct responses are 29, 31, and 33. Choice 32 is not correct because the scoop should not be taken in by the last open crosscut before a methane test is made. Choices 29 and 31 are correct. It is important to check and maintain good ventilation. Choice 33 is also correct. Miners should be aware of the symptoms of CO poisoning, of poisoning due to other mine gases, and of oxygen deficiency.

## **References**

Ellis, C.E., Schmidt, W.R., and Watson, A.K., Report of Multiple Fatal Explosives Accident (Carbon Monoxide Poisoning), No. 3 Mine (ID No. 15-13127), August 15, 1985.

Forbes, J.J., and Grove, G.W. (1954). Mine gases and methods for detecting them (Miner's Circular No. 33). Washington D.C.: U.S. Bureau of Mines.

Kumar, S. (1985). Mine gases. In F. Cameron (Ed.), The Kentucky underground coal mine guidebook (pp. 119-129). Lexington, KY: The Kentucky Mining Institute.

Hartman, H. L., Mutmansky, J. M., & Wang, U. J. (1982). Mine ventilation and air conditioning (2nd ed.). New York: Wiley.

## Scoring Key for the Lingering Smoke Exercise

The correct answers are marked with an asterisk.<sup>4</sup>

Question	Answer Number				
A	1	2*	3	4	
B	5	6	7	8*	
C	9	10	11*	12	
D	13	14	15*	16	
E	17*	18	19	20	
F	21	22	23	24*	
G	25	26	27*	28	
H	29*	30	31*	32	33*
F	32	33	34*	35*	

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<sup>4</sup> 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. To save effort and money, ask the trainees to avoid marking in the booklets and collect all the booklets after the class.

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](mailto:minetraining@cdc.gov).

# **Lingering Smoke Exercise**

## **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 9 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!" One question asks 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.

## Lingering Smoke Exercise

### **Background**

Drift mine  
28 inch coal  
Shooting from the solid in virgin coal  
Scoop haulage  
Good top

### **Problem**

You are one of three scoop operators. During the first part of the shift, entries 1 and 2 were loaded. Entry 3 was shot and partly loaded. One of the other scoop operators, Speedy, complained that he was dizzy and sick to his stomach when he was at the face. Otherwise the shift has gone as usual.

It is now lunch time. Entry 4 (the heading and the right crosscut) was just shot. You and the rest of the crew are eating lunch outside and waiting for the smoke and fumes to clear before you reenter the mine to clean up entry 3 and load out 4.

Figure 1, on the next page, shows a map of the section. Ventilation and the location of the phone and SCSRs are just as they appear. After studying the figure, turn the page and answer the first question.

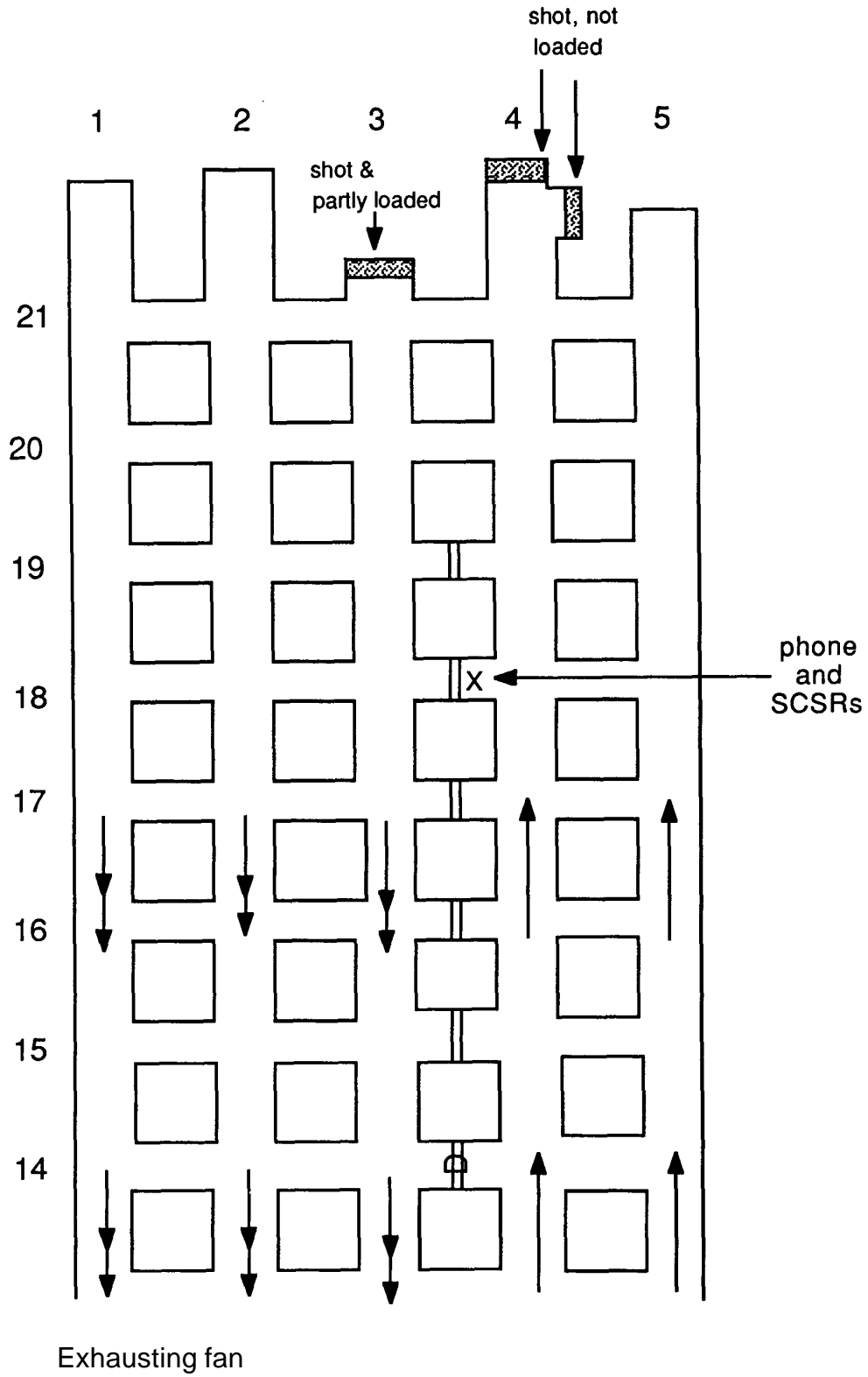


Figure 1: Section Map



**Question A**

Speedy and Chester, the third scoop operator, tram their scoops in to start loading out entry 4. The assistant foreman is riding to the face with Speedy. You get into your scoop and follow them in on your way to clean up entry 3. When you get to cross cut 20 you see that some smoke is still hanging. The first two scoops have already started into entry 4. The smoke looks thicker there. What should you do? (Choose only ONE unless you are told to "Try again!")

1. Stop your scoop and go into the entry to see what the others are going to do about the smoke.
2. Yell and ask the assistant foreman if he wants you to hang a check curtain in number 20 crosscut between entries 3 and 4.
3. Go on to entry 3 and do your job.
4. Hang a line curtain into entry 3 before you begin cleaning it up.

**Question B**

When you bring the last load outside from entry 3, the drill man and shooter ask for a ride to entry 1. You tell them that you feel dizzy and sick to your stomach. The driller says, "You scoop operators, you're always complaining about something."

As you go toward the face of entry 1, you pass Speedy's scoop. He says that Chester's scoop is stuck in the mud and he's on his way back from the shop with a chain to pull him out. He tells the drill man that the assistant foreman is marking entry 5.

After you drop off the drill man and shooter, you return to entry 4. As you go toward the entry, Speedy yells that Chester has passed out on his scoop. What should you do? See the map on page 6 for the locations of people and equipment. (Choose only ONE unless you are told to "Try again!")

5. Telephone outside for help.
6. Go get the assistant foreman.
7. Go in and help pull Chester out of his scoop.
8. Tell Speedy to get out of the entry.

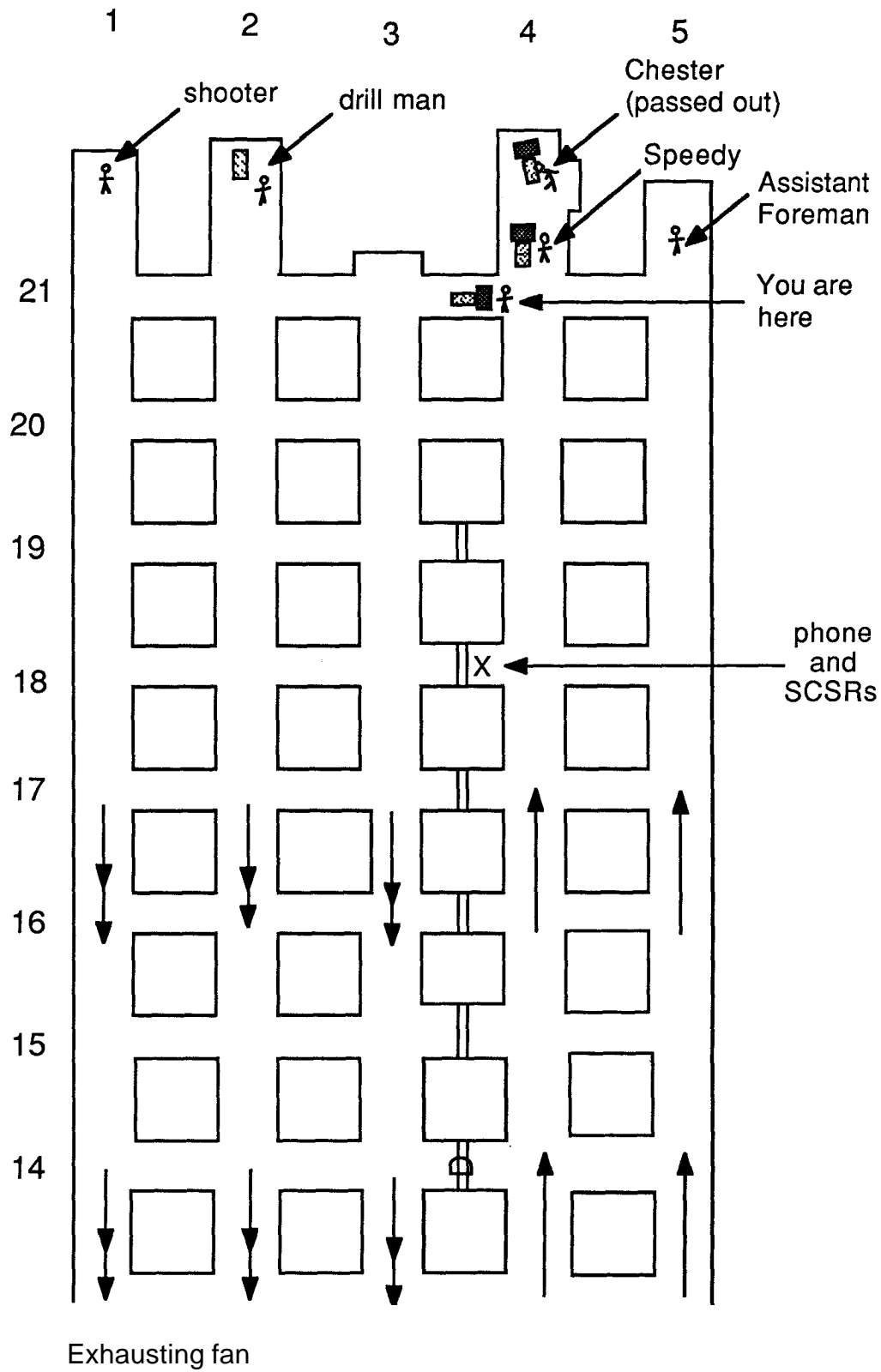


Figure 2: Section map with location of people and equipment

**Question C**

Speedy yells that he will not leave Chester. What should you do now? (Choose only ONE unless you are told to "Try again!")

9. Go into the entry and help Speedy so that he can get Chester out faster.
10. Go look for ventilation curtain while Speedy helps Chester.
11. Go get the assistant foreman.
12. Go to Speedy and force him to come out of the entry.

**Question D**

The assistant foreman tells you to go call outside for an ambulance while he helps Speedy with Chester. You go and make the call. When you get back to entry 4, you see that Speedy is down near Chester's scoop. The assistant foreman is slowly moving toward them. What should you do? (Choose only ONE unless you are told to "Try again!")

13. Go into the entry and help the foreman take care of Chester and Speedy.
14. Run into the entry to get the assistant foreman and bring him out of the entry.
15. Yell to the assistant foreman to get out and then go get the shooter and drill man to help you.
16. Go get some SCSRs and then come back to help the assistant foreman and scoop operators.

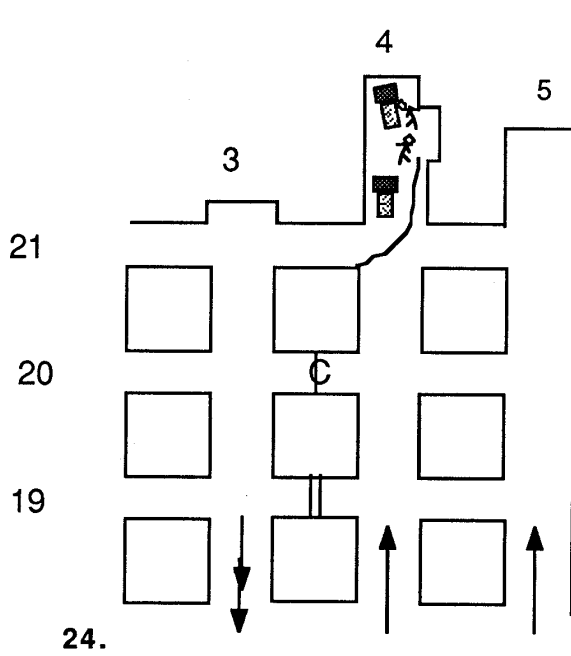
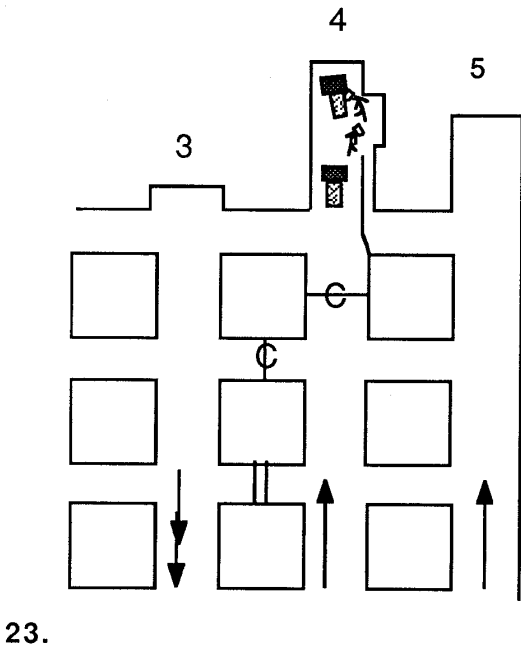
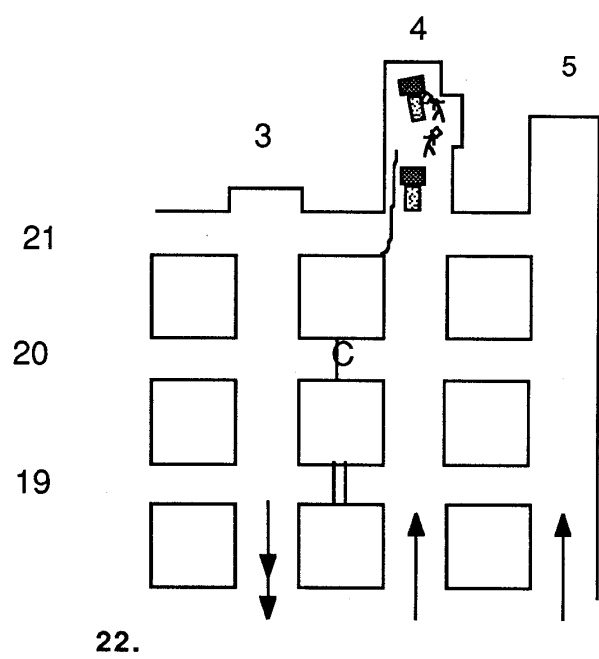
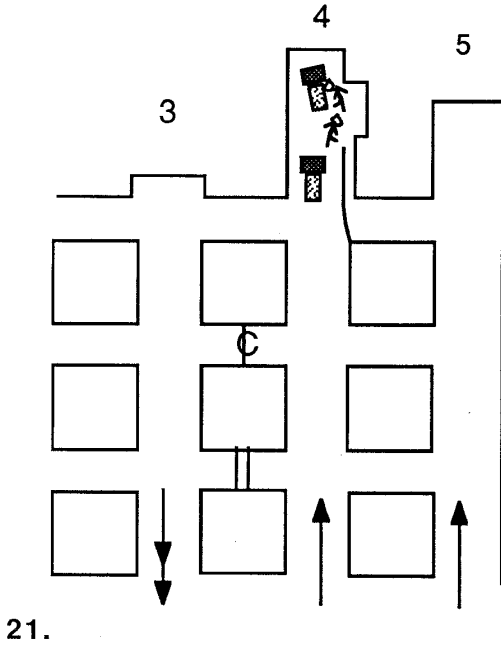
**Question E**

When you, the shooter, and the drill man get to entry 4 the assistant foreman is down. How should you help the three unconscious miners? (Choose only ONE unless you are told to "Try again!")

17. Ventilate entry 4.
18. Each of you hold your breath, then go in and drag the men to safety.
19. All of you should get the SCSRs, put them on, and go in and drag the men to safety.
20. Call for a mine rescue team.

**Question F**

In order to quickly and safely ventilate entry 4, which map shows how you should hang curtains? (Choose only ONE unless you are told to "Try again!")



**Question G**

You have decided on the best way to ventilate #4 entry. Now you need to recover the victims. What is the safest way do this? (Choose only ONE unless you are told to "Try again!")

25. Call outside for a CO spotter.
26. Don't try to recover victims yourselves. Wait for the rescue team.
27. Advance the curtain up the right side of entry #4, keeping yourselves in good air.
28. Install line posts on 5-foot centers on the right side of the entry. Hang a line curtain on them as you advance.



**Question H**

You and your two buddies bring the three victims out of the mine and they are taken to a local hospital. Chester died from CO poisoning, but Speedy and the assistant foreman survived.

Looking back on the accident what things should have been done to prevent it? (Select as MANY as you think are correct.)

- 29. Preshift examination should have indicated that ventilation had fallen behind.
- 30. A flame safety lamp should have been used to check for CO as soon as Chester went down.
- 31. The assistant foreman and crew members should have detected and corrected inadequate ventilation.
- 32. Gas checks should have been made as soon as scoop reached the working face.
- 33. You and Speedy should have questioned why you were feeling ill.

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

## **Question I**

On your answer sheet, list all of the federal, state or company violations, or bad practices, that occurred in this problem.

## **End of Problem**

This exercise is based on an actual accident in which 3 miners were killed and another was hospitalized. The miners' failure to recognize CO poisoning and their returning to bad air in attempts to rescue others contributed to their deaths.

### **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 23. 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 33 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](mailto: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 Lingering Smoke Exercise

Use this answer sheet to mark your selections. Rub the special 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. [ ]

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

9. [ ]

10. [ ]

11. [ ]

12. [ ]

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

13. [ ]

14. [ ]

15. [ ]  
[ ]

16. [ ]  
[ ]

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

17. [ ]

18. [ ]

19. [ ]

20. [ ]

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

21. [ ]

22. [ ]

23. [ ]

24. [ ]

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

25. [ ]

26. [ ]

27. [ ]

28. [ ]

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

29. [ ]  
[ ]

30. [ ]  
[ ]

31. [ ]  
[ ]

32. [ ]  
[ ]

33. [ ]  
[ ]

**Question I**

END OF PROBLEM

**Finding your score**

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

23 minus the number of incorrect answers you colored in = (2) \_\_\_\_\_

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

Highest possible score = 33

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.

The assistant foreman tells you to go load entry 3 like you're supposed to. Try again!

Correct! The assistant foreman tells you that he will take care of it later. Do the next question.

There is something else that you should do now. Try again!

Entry 3 doesn't need a curtain for ventilation. Try again!

There is something you should do first. Try again!

There is something you should do first. Try again!

This is not the best thing for you to do. Try again!

Correct! Do the next question.

This will put you and Speedy in danger. Try again!

This is not the best thing to do now. Try again!

Correct! You go to entry 5 and tell the assistant foreman that Chester is down. Do the next question.

This will put you in danger. Anyway, this is not the time to argue with Speedy. Try again!



Soon all of you are down and no one is left to help you. Try again!

This will put you in danger. Try again!

Correct! The assistant foreman keeps moving toward the face. You tram your scoop to entries 1 and 2 and pick them up. Do the next question.

Although this is a tough decision to make, SCSR's are to be used only for escape... not for rescue. Try again!

Correct! This is the safest option. Do the next question.

This is not possible. You would be overcome. Try again!

SCSR's are not to be used for rescue. Try again!

By the time they arrive, it will be too late to help the victims. Try again!

This will not ventilate entry 4. Try again!

This is not the best way to ventilate entry 4. Try again!

This is not the best way to ventilate entry 4. Try again!

Correct! This is the best way to ventilate entry 4. Do the next question.

This is not the best thing to do. Try again!

There may not be enough time to wait for the rescue team. Try again!

Correct! Do next question.

This is not the best thing to do. Try again!

Correct! The ventilation as shown on Figure 1 was not adequate. This should have been noted during the preshift examination and corrected.

A flame safety lamp will not tell you when small but deadly levels of CO are present.

Correct!

Equipment should not be taken into the working face until a methane test is made.

Correct! Miners should know symptoms of CO poisoning, of poisoning from other mine gases, and of oxygen deficiency.