Cutthrough Ventilation Arrangements

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.

Contents

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 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:	Twelve questions (45 minutes for administration plus one hour for discussion)
Audience:	Experienced underground miners
Skills:	Mine ventilation basics Reading ventilation maps and schematics Making airflow and gas measurements from which to judge the adequacy of the mine ventilation Applying correct procedures when cutting through from one section to another Diagnosing ventilation problems and errors given a set of air quantity and quality measurements Anticipating likely errors and preventing their occurrence when connecting two separate air splits with a cutthrough Selecting escape routes from a mine section with dangerous levels of methane accumulation
Location:	Underground
Problem:	Three shifts on two sections are driving entries 4,800 feet from the mains to form a retreating longwall panel. The mine is very gassy. One section is about to cut through to the other. A number of problems develop. You need to make sure the cutthrough proceeds safely and that the ventilation for both sections remains adequate. As the problem develops, other miners make errors. If you do not correct them, lives may be lost.

[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 or illustrations on an overhead projector so you can use these to help explain the problem.

6. When you present the exercise to the class:

   - Arrange class members into small groups of from two to five persons.

   - Give each person an exercise booklet, and each small group 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, give each group a copy of the scoring key and discussion notes. Have them figure up their score and go over the notes.

   - When everyone has finished, discuss the exercise. Let class members discuss the merits of each answer. Add your own ideas.

Performance Objectives for Cutthrough Ventilation Arrangements

Objective number		Capability verbs	Description of required performance and conditions under which it is to occur
1.	MG/EE[3]	Identify Interpret Recognize	Ventilation arrangements, structures, airflow routes and specific positions given a mine map and ventilation schematics for that mine map
2.	MG/EE	Match Recognize	Corresponding features of a ventilation schematic for a more detailed mine map
3.	MG/EE	Recall Comprehend	That total air inflow to a mine section must equal total outflow, except for leakage, when a mine section has no connection to another section
4.	MG/EE	Recall Infer Predict	The typical location and effects of a regulator on the airflow distribution to a mine section given a mine map and ventilation schematics with airflow readings
5.	MG/EE	Infer Predict	Likely changes in the ventilation of two mine sections when one section cuts through to another given airflow readings for both sections before the cutthrough
6.	MG/EE	Recognize Recall Select	Methods and means to determine changes in airflow distribution after a cutthrough between two independently ventilated mine sections
7.	MG/EE	Select	Critical locations at which airflow and methane measurements must be monitored before, during, and after a cutthrough from one section to another, and after a cutthrough has inadvertently been left open
8.	MG/EE	Select Predict	Critical locations on a mine section at which a few air flow and methane measurements will maximize information about conditions on the section
9.	MG/EE	Infer Judge Evaluate	Conditions on a mine section given a profile of airflow and methane measurements taken at given locations
10.	MG/EE	Recognize Discriminate	Conditions that require immediate evacuation of personnel from a dangerous situation in a mine, given a profile of

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

		Identify	methane and airflow readings at a few critical points
11.	MG/EE	Identify Infer Evaluate	Alternative routes and procedures for the emergency evacuation of personnel from a mine section given a mine map and airflow and methane readings that indicate conditions for a possible explosion
12.	MG/EE	Recall Recognize Identify	Mining practices and procedures that prevent airflow distribution and methane accumulation problems when cutting through from one section to another

More About the Exercise

This exercise is designed to supplement the MSHA Ventilation Awareness Program that is cited in the references. The exercise is based on the Delta Mine case study included in the Ventilation Awareness Program. The original accident investigation upon which the case study is based was also used in the construction of the exercise, as well as related accident investigations where open cutthroughs from one mine section to another resulted in explosions and loss of miners' lives. These accident reports and other relevant materials are also included in the references. Instructors may wish to refer to these source materials, but it is not necessary to do so to use the exercise.

An Alternative, More Difficult Exercise

The Delta Mine Cutthrough exercise is an alternative version of this exercise. This alternative exercise is more difficult because it requires persons to generate answers to questions rather than to recognize good and bad responses from lists of alternatives. This other exercise also provides less immediate feedback. Correction of errors for each section of the problem occurs from the information in the next question, discussion of miners as they work the problem in their small groups, and from the instructor during the class discussion following the exercise. The Delta Mine Cutthrough exercise is more realistic in the sense that more of the problem formulation and solution must be structured by the miners than in the Cutthrough Ventilation Arrangements exercise. Consequently, the Delta Mine Cutthrough Exercise demands more from the miner and it takes more than an hour to complete. An additional hour is also needed for class discussion after miners work the exercise. The Cutthrough Ventilation Arrangements exercise explicitly teaches basics that are involved when cutting through from one section to another. It also teaches some other content and basics related to reading and interpreting mine ventilation maps and schematics, and selecting escape routes. The more difficult Delta Mine Cutthrough exercise may be used to teach these same basics but depends upon the instructor's initiative to do so. Instructors may wish to review both exercises to make a decision concerning which one best meets the skill levels of class members and the time available for instruction.

Master Answer Sheet for Cutthrough Ventilation Arrangements

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.

Question A (Choose only ONE unless told to "Try Again!")

1. [**D** is the intake. The return for 2 Left is labeled **E**. Try again!]

2. [Correct! Do the next question.]

3. [**A** and **B** are the 2 Left intake and return. The setup entries are marked with]
   [a **C**. Try again!]

4. [The black dots mark the splitting of air at the intakes and returns. The]
   [overcasts are not shown. Try again!]

Question B (Choose only ONE unless told to "Try Again!")

5. [Try again!]

6. [Correct! The intake and return flow must be the same. Do the next question.]

7. [Try again!]

8. [Try again!]

9. [Try again!]

Question C (Choose only ONE unless told to "Try Again!")

10. [Try again!]

11. [Try again!]

12. [Try again!]

13. [Correct! Do the next question.]

14. [Try again!]

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

15. [Try again!]

16. [Try again!]

17. [Try again!]

18. [Correct! The only way to know for sure is to make air measurements after the cutthrough is completed. Do the next question.]

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

19. [Correct! But, you must measure the airflow to be certain.]

20. [There may be changes in airflow elsewhere.]

21. [The changes can be much larger.]

22. [It is unsafe and illegal to leave the cutthrough open.]

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

23. [Ten minutes after you put the curtain up, an explosion occurs on 2 Left. It kills you and all the other miners on the section. Try again!]

24. [Correct! Now you have to decide where to take the readings. Do the next question.]

25. [He says, "Sure! It's been open all night and the ventilation is OK" Try again!]

26. [You leave it open. An hour later there is an explosion on 2 Left. It kills all the miners on the section. Try again!]

Question G (Choose as MANY as you think necessary, but no more than four.)

27. Point A [methane = 0.15 %, airflow = 36,500 cfm]

28. Point B [methane = 0.15 %, airflow = 20,000 cfm from 1 Left to 2 Left.]

29. Point C [methane = 2.50 %, airflow = 23,000 cfm]

30. Point D [methane = 1.40 %, airflow = 12,000 cfm]

31. Point E [methane = 0.15 %, airflow = 15,700 cfm]

32. Point F [methane = 2.50 % airflow = 18,000 cfm]

33. Point G [methane = 1.30 % airflow = 43,000cfm]

34. Point H [methane = 12.00 %, airflow = 5, 000 cfm]

35. Point I [methane = 1.30%, airflow = 43,000cfm]

36. Point J [methane = 0.15%, airflow = 16,000cfm]

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

37. [Correct! A methane explosion is possible at any moment. There may be]
[explosive levels of methane in the primary and secondary escapeways. No]
[equipment should be operated.]

38. [Correct! You knock the power. Your spotter shows 2.3% methane at the]
[power box. Meanwhile, the 2 Left foreman makes a headcount and sends]
[all the miners out.]

39. [When you do this, there is a spark. The methane ignites. You and the]
[foreman are killed in the explosion. Some of the miners walking out are]
[also killed and others are badly burned.]

40. [When you do this, there is a spark. The methane ignites. You and the]
[foreman are killed in the explosion. Some of the miners walking out are]
[also killed and others are badly burned.]

41. [Correct! All power has been knocked. All miners are out. When you close off]
[the cutthrough, the ventilation for the two sections should soon return to]
[normal. The high levels of methane in the intake and neutral air entries of]
[2 Left should be reduced.]

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

42. [The #2 entry is the designated primary escapeway, but it is not a good]
[choice in this situation. Try again!]
[ ]
[ ]

43. [This is not the best choice. There is a better alternative. Try again!]

44. [Correct! This is the safest route. Methane is present in the explosive range]
[in much of the 2 Left entries. Leaving this way would expose miners to a]
[long and dangerous trip. However, the air in the setup entries and 1 Left is]
[OK. Do the next question.]

45. [This is not a good choice. There is a better alternative. Try again!]

Question J (Choose only ONE unless you are told to "Try Again!")

46. [Try again!]
[ ]

47. [Correct! The flow in one intake may increase and the flow in the other intake]
[decrease by a large amount, as happened in this problem. With a decrease]
[in intake airflow in 2 Left in this problem, dangerous levels of methane built]
[up along the rib of the longwall panel. Do the next question.]

48. [Blackdamp is oxygen deficient air. Firedamp is methane. Neither can be]
[produced by mixing wet and dry air. Try again!]

49. [Try again!]

Question K (Choose only ONE unless you are told to "Try Again!")

50. [This is not practical and is not required by law. Try again!]

51. [Correct! This is practical and easy to do. It is also required by law. Do the]
[next question.]

52. [This is an improper and dangerous procedure. Try again!]

53. [This is an improper and dangerous procedure. Try again!]

Question L

Describe the mining and communication procedures that should have been used when cutting through from one section to the other to prevent ventilation problems and accidents. Write on this page. Use the back of the page if you need more space.

Finding your score

Number of “Correct” answers you colored in	=	(1) _____
37 minus the number of incorrect answers you colored in	=	(2) _____
Add blanks one and two to get your total score	=	(3) _____

The highest possible score is 51.

The lowest is zero.

Discussion Notes for Cutthrough Ventilation Arrangements

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 answer is number 2. The purpose of this question is to see if persons understand the schematic diagram. The diagram represents the main parts of the mine map shown in Figure 1.

Question B The correct answer is number 6. The schematic in Figure 3 shows that 19,000 cfm is flowing out the return air entry for 1 Left section. This section has only one split of intake air from the main intake air course, and only one junction with the return air course in the mains. There are no other connections between 1 Left and other sections in the mine. Excluding leakage from the section, the amount of air flowing in must equal the amount flowing out. Therefore, the intake airflow must also be 19,000 cfm.

Question C The correct answer is 13. From inspection of the map in Figure 1 and the schematic in Figure 3 the following points can be noted. First, both the 1 Left and 2 Left sections each get their air from a single split from the main intake airway. Second, both sections are about the same length. Third, the combined neutral and intake airflow into 2 Left is 42,000 cfm. The return airflow for 2 Left is also 42,000 cfm. Fourth, the return air flowing out of 1 Left is only 19,000 cfm (see the notes for Question B), and the intake airflow in 1 Left is also 19,000 cfm. Fifth, 2 Left has more than twice the total airflow of 1 Left. Sixth, the length and cross sections of the two sections are approximately equal. Seventh, the pressure of air available to both sections should be about the same because the two intakes and returns for the sections are fairly close to each other in the mains. Therefore, the quantity of air flowing to both sections should be approximately the same. From all this information it is apparent that there is a restriction somewhere in 1 Left that

prevents more air flow. This is most likely a regulator. Regulators are usually placed in the return air entry just before the junction with the main return air course. Here the 1 Left section air was regulated. However, the 2 Left section air was not regulated because methane had been a problem. The 42,000 cfm to the section was needed to keep the methane clear. The 1 Left section had much less methane and needed less air for its proper ventilation.

Question D The correct answer is 18. This is a tricky question. Given what you already know about the air being regulated in the 1 Left return but not in 2 Left, and given the higher airflow in the 2 Left section, the direction of flow after the cutthrough will probably be from point A to point B (from 1 Left through the setup entries into 2 Left). However, this assumes there are no other ventilation changes on the 2 Left or 1 Left sections. Ventilation changes that could change the airflow might result from:

a) a large roof fall in the intake, neutral, or return air entries on 2 Left,

b) an inflow of water to a low spot in 2 Left entries that could reduce the cross section area of intake, neutral, or return entries or all three, and

c) inadvertent blockage of airflow in 2 Left intake, neutral, or return air by wrongly placed curtains or equipment.

So, the only way to know for sure which way the airflows after the cutthrough is to make measurements at the cutthrough. However, it is best (and required by CFR 75.322) to keep the sections separate.

Although this is a tricky question, it is no more tricky than real-life cutthrough situations that have occurred. In some cases like this one, wrong decisions have been made and miners have died.

Question E The correct answer is 19. All other statements in this section are false. Given the information you have gathered so far, the increased airflow in 2 Left is probably from the 1 Left section. But you can't be sure without taking measurements. The increased flow could result from changes in 2 Left's ventilation. (See the notes for Question D.) Statement 20 is false because the airflow readings shown in Figures 5A and 5B are only for the returns. The airflow in the returns can change very little after the cutthrough, or not at all. Yet, there can be great changes in the intake entries airflow. In this problem, after the cutthrough, the intake airflow in 1 Left increased from 19,000 to 36,000 cfm. Yet, the 1 Left return dropped only 3,000 cfm from 19,000 to 16,000 cfm. The extra intake air from 1 Left found a pathway of less resistance into 2 Left because the 1 Left return was regulated and 2 Left was not. This extra 20,000 cfm of air from 1 Left into 2 Left through the cutthrough increased the airflow in the 2 Left return by only 3,000 cfm from 40,000 to 43,000 cfm. Yet the intake airflow on 2 Left, along the gassy rib of the longwall panel, dropped more than 50% (more than 20,000 cfm).

To know how air quantity and quality have changed after a cutthrough is left open, airflow and methane measurements must be taken in both intakes and returns of both sections. Because the changes to ventilation can be great from a cutthrough, the law requires that the ventilation to the sections be kept separate. Statement 20 is also false for the reasons explained above. Statement 22 is false. It would not be all right to leave the cutthrough open under any conditions. In addition, regulating the air in the 2 Left entry at the junction with the main return could restore the return readings to the values in Figure 5A. It could also prevent the flow of air from 1 Left into 2 Left section. But to do so, the airflow in both the 2 Left intake air entry and the return entry would have to be cut to less than half of the 40,000 cfm. Such a procedure would allow the accumulation of methane in 2 Left and would be very dangerous.

Question F The correct answer is 24, to take methane and airflow readings. Curtaining-off the cutthrough after it has been open for 9 hours will immediately increase the flow of intake air in the 2 Left intake and neutral air entries. Because the airflow in these entries has been sluggish during the 9 hours the cutthrough was left open, methane may have accumulated. When the fresh air comes into this area after the curtain is up it can mix with the methane and put it into the explosive range (5 to 15 %). When the day shift on 2 Left begins work, or when a sump pump comes on, or when the methane-air mixture near the motor on the belt drive gets into the explosive range, an explosion could occur. The examiner should not ask the maintenance crew what he should do. He needs to act right away. No matter how long the cutthrough has been left open, the airflow will not "equalize" and restore the proper ventilation. The sections should have been kept separate from the time of the cutthrough. Since the cut was left open for so long, it made a major and dangerous change to the ventilation of the sections. To close it off will make another dangerous and major change to the ventilation of the sections. If the examiner leaves the cutthrough open, an explosion is also likely because methane is likely to accumulate to the explosive range if it has not already done so. If the methane measurements made before the curtain is hung show dangerous levels of the gas is present, the power to the sections should be knocked and all personnel immediately evacuated from the mine. Only after the power has been knocked and the miners evacuated should the curtain in the cutthrough be hung (CFR 75.322). This job should be performed by a person(s) designated by the mine operator to make major ventilation changes (CFR 75.309).

Question G Only a few airflow and methane readings are needed to figure out what has happened on the section and what needs to be done. Most persons would probably take readings at point B because the examiner is in that spot when he or she notices the cutthrough is open. The examiner should suspect the cutthrough may have been open for a long time, even if he or she did not find someone to ask. To assume otherwise would be dangerous. A measurement at point B shows 20,000 cfm of air with only 0. 15% methane is flowing from 1 Left to 2 Left. A measurement at point E shows that only 15,700 cfm is flowing out of the 1 Left returns and that the methane level is still 0. 15%. These two sets of measurements tell you two things. First, you know there must be about 36,000 cfm of airflowing at point A. (The flow at A = flow at B + flow at E.) Second, you know there is not a methane problem in the setup entries or from 1 Left. Next you would want to measure at point C. This measurement produces a methane value of 2.50% and an airflow of 23,000

cfm. Now you have all the information you need to act quickly. You know the methane is dangerously high and that the intake air to 2 Left has dropped by nearly 20,000 cfm from the day before. You should realize the source of the methane and a likely accumulation point is along the longwall rib in the belt entry of 2 Left. At this point you have enough information to act. You should knock the power to the section and order everyone out. You need to measure airflow and gas concentration at only three points to get the information you need. Can you think of three other points that would serve as well?

You should also monitor for methane as you travel on the section to knock the power and to tell others to leave. But you probably would not want to take time to make more airflow readings. It would be foolish to take airflow and methane readings at points J, D, 1, and H unless you had to go there for some other reason. You need to act rapidly and not waste time. The 2 Left day shift is about to begin work and can easily ignite the methane with their equipment.

Question H the correct answers are 37, 38 and 41. You should order everyone to walk off the section except for one helper because there is danger and you are about to make a major ventilation change to restore ventilation. No equipment should be operated. You should immediately knock the power to the entire section for the same reason. However, disconnecting the pager is dangerous because it could cause a spark and trigger an explosion. You should report the conditions on the section to the surface, but not by using the pager that is not permissible. Rather, you should instruct the miners leaving the section to report to the surface. You should also have them monitor for methane on their way out, and travel through the intake air course in the setup entries to the 1 Left section where they can warn others and call out to the surface and then continue on outside. Only after all this is done should you and the foreman hang a curtain across the cutthrough. You will be making a major change to the ventilation. The power must be off. All unnecessary personnel must be removed (CFR 75.322).

Question I The correct answer is 44. Both the miners you sent out earlier and the foreman and you should leave through the setup intake air entries. This is the safest route. Should there be an explosion while you are leaving, the intake air will help protect you from smoke and gases that could come into the setup entries from 2 Left. It is dangerous to go out the 2 Left entries, even if you travel in the intake air entry (the designated primary escapeway for 2 Left). This route is too close to the high methane accumulation that is probably located in the 2 Left #1 belt entry. In the event of an explosion the intake air entry would probably become impassable and might also be included in the extent of the fire and blast effects.

Question J The correct answer is 47. The reasons are explained in the invisible ink message following the answer and in the notes for Questions E and F above.

Question K The correct answer is 51. It is not necessary to construct permanent stoppings in the cutthrough and it is impractical to do so. Soon the ventilation to the longwall will be changed. The 2 Left entries will become the headgate and the intake air entries for the longwall panel. The 1 Left entries will become the tailgate and the return air

entries. Until that time a tightly hung curtain at crosscut 40 will serve to keep the ventilation to the two sections separate and maintain proper ventilation on both sections. The other statements are incorrect for reasons stated in the notes for other questions.

Question L

Some of the mining and communication procedures that should be established before the cutthrough include:

a) Management and engineering staff should anticipate the cutthrough long before the actual work is to be done. Specific procedures for making the cutthrough should be written down and communicated to the section foreman, the maintenance foreman, all mine examiners, and the miners on all shifts on both sections before the cutthrough is to take place.
b) The cutthrough plans, including the mining and communication procedures to be followed, need to be presented to state and federal inspectors prior to the actual cutthrough.
c) At the time of the cutthrough, accurate surveys should be available to indicate the exact points and probable times for the connection.
d) The foremen of the section crews on the sections at the time of the cutthrough should talk with one another and with the general mine foreman prior to the shift for which the cutthrough is planned. It should be agreed which crew will cutthrough to which section, at what location and time.
e) All miners on both sections should be briefed on when and where the cutthrough is to take place and what ventilation and other procedures are to be followed before, during, and after the cutthrough, e.g., location of equipment and miners, specific ventilation arrangements on both sections, changes in mining operations and sequence, if any, etc.

References

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Other references consulted in the construction of this exercise include:

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Scoring Key for Cutthrough Ventilation Arrangements

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*	14	
D	15	16	17	18*		
E	19*	20	21	22		
F	23	24*	25	26		
G	choose only four		27*	28*	29*	30
	31*	32*	33*	34	35	36
H	37	38*	39	40	41*	
I	42	43	44*	45		
J	46	47*	48	49		
K	50	51*	52	53		

[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.

Cutthrough Ventilation Arrangements

Problem Booklet

Instructions

Read the problem described on the next page. Then answer the twelve questions. Do them one at a time. Don't jump ahead, but you may look back to earlier questions and your answers. Most questions direct you to select only one answer unless you are told to "Try again!" Other questions tell you to choose as many answers as you think are correct. Follow the directions for each question.

After you have selected your choice to a question, look up the number for that choice on the answer sheet. Rub the developing pen between the brackets for that choice. A hidden message will appear that tells you if the choice is correct and provides you with additional information. When you finish, you will learn how to score your performance.

Background

In mining sometimes one section cuts into another section. Examples include intentionally cutting into old works to establish a new ventilation arrangement or setting up a longwall panel.

Look at the map in Figure 1 on the next page. It shows two sections being driven 4,800 feet from the mains to develop a retreating longwall panel. The 1 Left section has four entries with a single air split. The 1 Left section crew has finished the entries and most of the longwall setup entries that will soon connect 1 Left with 2 Left. The 2 Left section has three entries with a single air split. The mine is very gassy. It liberates from 2.6 to 3.2 million cubic feet of methane a day at the fan that exhausts 690,000 cfm. The rib of the longwall panel along entry #1 in 2 Left section is especially gassy.

Problem

This exercise asks you questions about the ventilation arrangement for the sections shown in Figure 1. Study the map in Figure 1 on the next page. Then do the first question. Do each question in order. Don't jump ahead, but you may look back to earlier questions you have completed.

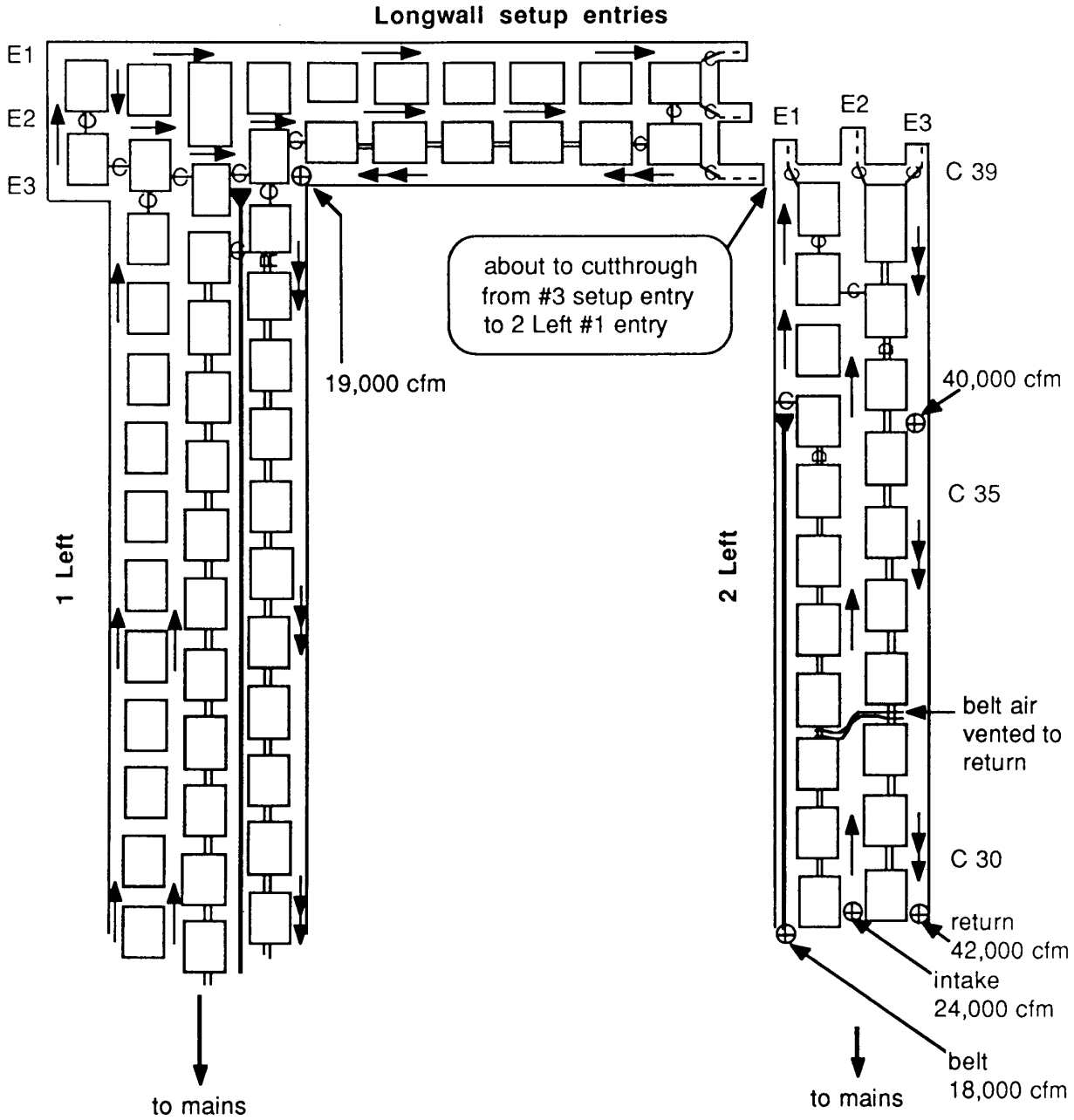

Figure 1: Mine ventilation before cutthrough from setup #3 entry to 2 Left section

Question A

Figure 2 is a schematic diagram of the map in Figure 1. Study both Figures 1 and 2. Then read the four statements on this page. Select the one true statement. (Choose only ONE unless you are told to "Try Again!")

1. The return air entry for 2 Left section is marked **D** in Figure 2.

2. The mains from which 1 Left and 2 Left sections are ventilated are marked **F** and **G** in Figure 2.

3. The longwall setup entries in Figure 2 are marked with an **A** and **B**.

4. The overcasts where the return air in 1 Left and 2 Left cross the main intakes are shown as black dots in Figure 2.

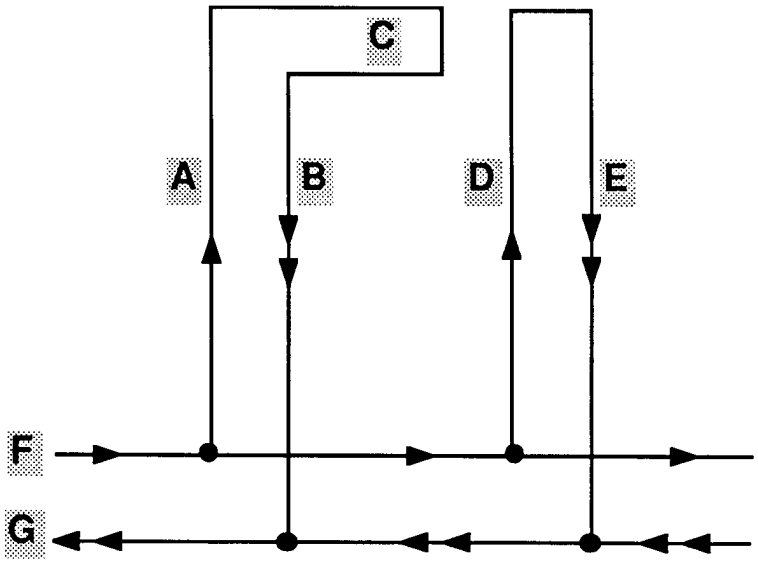

Figure 2: Simplified ventilation schematic for the map shown in Figure 1

Question B

Look at Figure 1 again. Then look at Figure 3. Approximately how many cfm of air should be present in the 1 Left intake air entry at the point indicated on Figure 3? (Choose only ONE unless you are directed to “Try Again!”)

5. 30,000

6. 19,000

7. 23,000

8. 14,000

9. 49,000

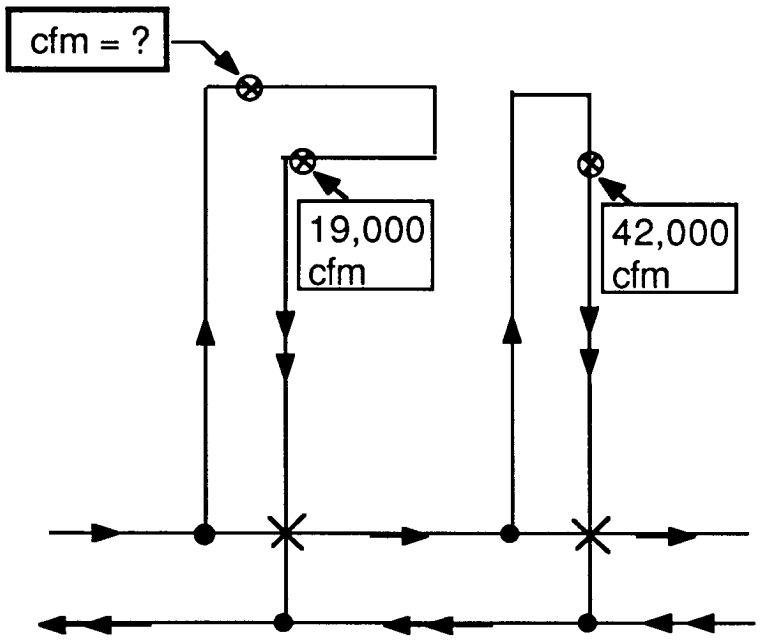

Figure 3: Estimate the airflow at the point indicated for the map shown in Figure 1

Question C

Look at Figure 1 and Figure 3. Remember that the intake air entries for both 1 Left and 2 Left sections get their air from the same intake aircourse in the mains and that both sections also exhaust their return air into the same return aircourse in the mains. Assume the length and cross sectional areas of the two sections are the same.

Using the information about airflow distribution in Figures 1 and 2, where is there most likely to be a regulator? (Choose only ONE unless you are directed to “Try Again!”)

10. In the setup entry return air entry.

11. In the 1 Left intake air entry.

12. In the 2 Left return air entry near the main return air entry.

13. In the 1 Left return air entry near the main return air entry.

14. In the intake air course in the setup entries, just before the face.

Question D

The 1 Left section crew has cut through to the 2 Left section as shown in Figure 4. The cutthrough is left open. What should you presume about which way the air will flow between 1 Left and 2 Left section? (Choose only ONE unless you are directed to "Try Again!")

15. Air will flow from point B to point A.

16. Air will flow from point A to point B.

17. The air will not flow either way, but remain still.

18. Without observing and measuring, it is impossible to be certain which way the air will flow.

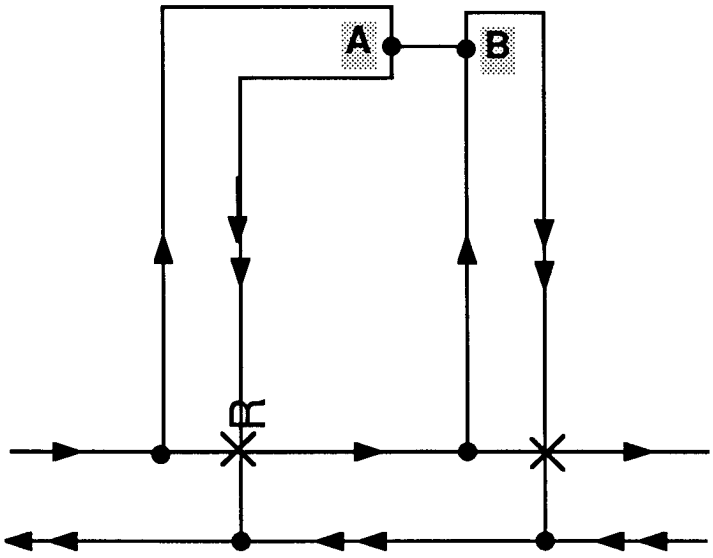

Figure 4: Cutthrough is through and open. Which way will the air flow?

Question E

Before the cutthrough between 1 Left and 2 Left sections was completed, the airflow readings shown in Figure 5A (on the next page) were taken in the returns at the points indicated. After the cutthrough was completed it was left open. The new airflow readings shown in Figure 5B were taken.

Study both Figures 5A and 5B. Then read the four statements on this page. Select all the true statements. (Select as MANY as you think are correct.)

19. The increased airflow in the 2 Left returns after the cutthrough is probably from the 1 Left section.

20. Because the airflow readings are only slightly different after the cutthrough, the ventilation elsewhere on the two sections can't have changed much either.

21. Any airflow changes in the 1 Left and 2 Left intake air entries after the cutthrough can be no more than 3,000 cfm.

22. After the cutthrough, a regulator is added to the return on 2 Left to try to stop the airflow between the sections. When this is done the airflow readings in the 1 Left return become the same as before the cutthrough (19,000 cfm). The airflow in the 2 Left return drops to 22,500 cfm. Now it is OK to leave the cutthrough open.

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

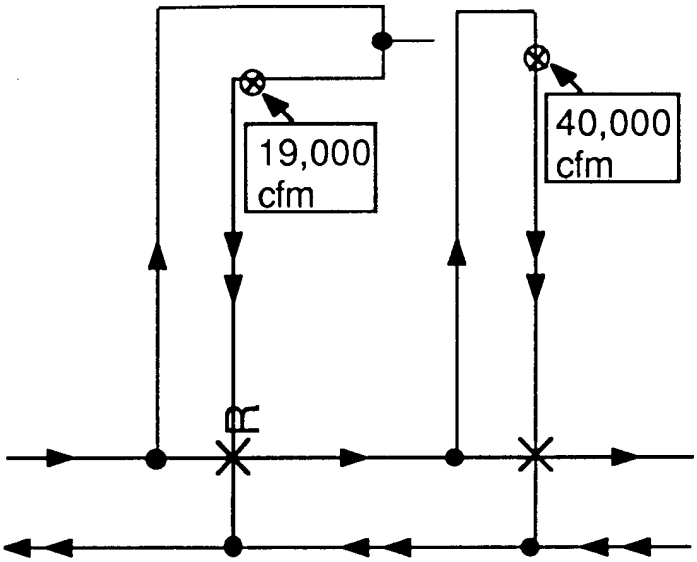

Figure 5A: Airflow readings before the cutthrough

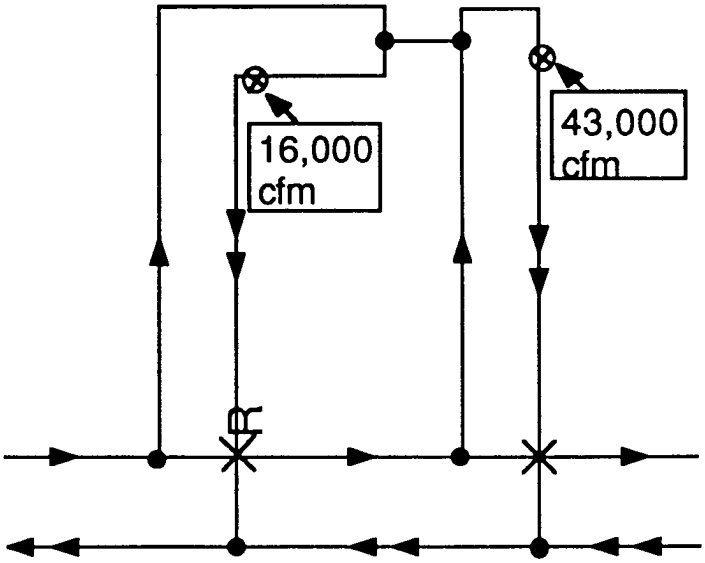

Figure 5B: Airflow readings after the cutthrough

Question F

It is a few days later. The first cutthrough is now curtained-off. Suppose you are the preshift examiner for the day shift. A maintenance crew is working in the setup entries repairing equipment. The 2 Left section foreman has just come on the section. The rest of the section crew is on the way in. When you come on the section you find a second cutthrough open between 1 Left and 2 Left. (See the map in Figure 6.) When you ask a mechanic, you learn the second cutthrough has been open for 9 hours. What would you do? (Choose only ONE answer unless you are told to "Try again!")

23. Immediately curtain-off the cutthrough.

24. Take methane and airflow readings.

25. Ask the 2 Left maintenance foreman if he wants the second cutthrough left open.

26. Leave the cutthrough wide open because it has been open long enough for the airflow between the two sections to have equalized.

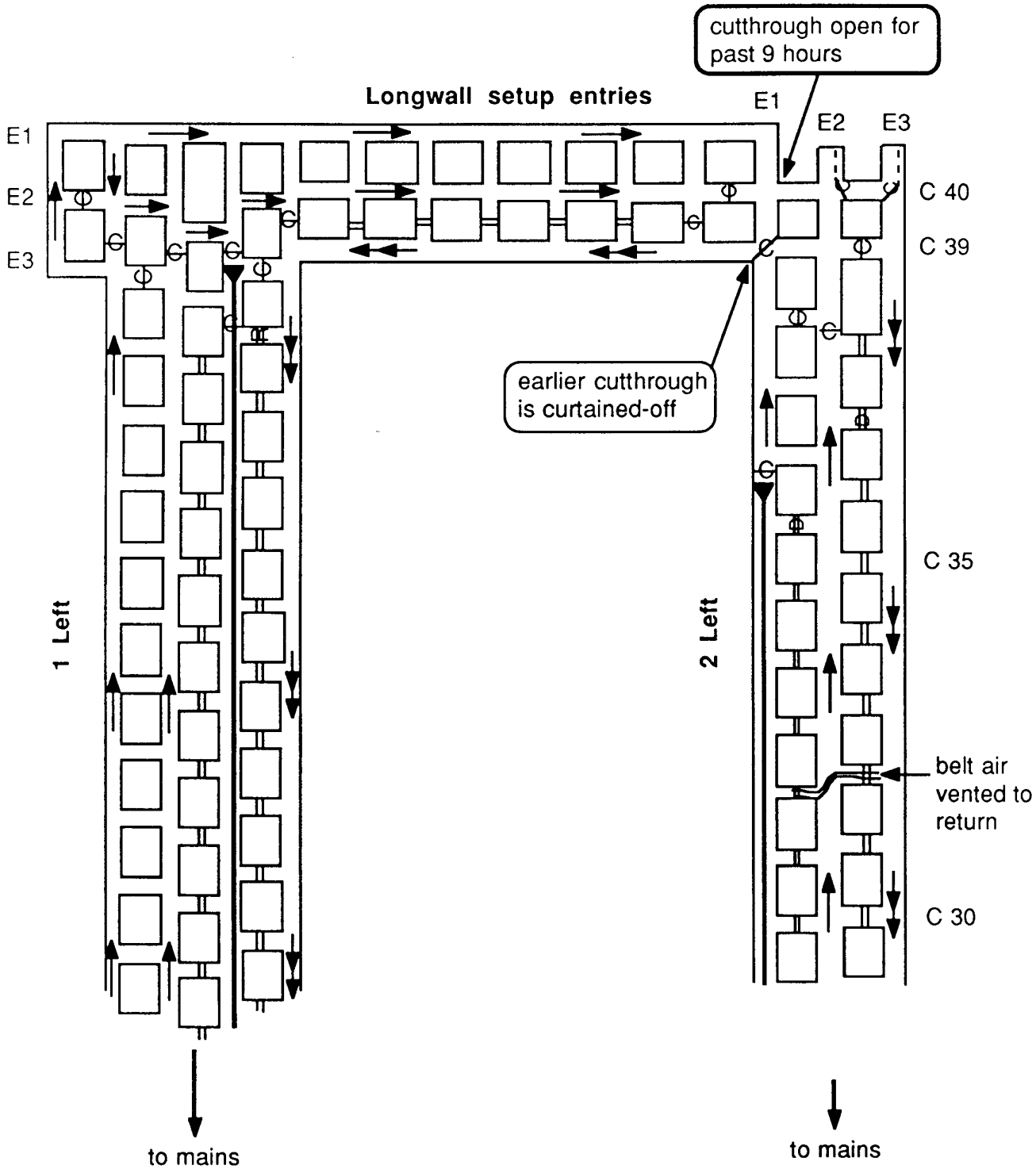

Figure 6: You discover the second cutthrough from the setup entries to the 2 Left section has been open for 9 hours.

Question G

Now you decide to take methane and airflow readings before you make any changes to the ventilation. Look at Figure 7. Select the four points at which you would take the readings. (Select as MANY as you think are necessary but **NO MORE THAN FOUR**. You need to act rapidly.)

27. Point **A**
28. Point **B**
29. Point **C**
30. Point **D**
31. Point **E**
32. Point **F**
33. Point **G**
34. Point **H**
35. Point **I**
36. Point **J**

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

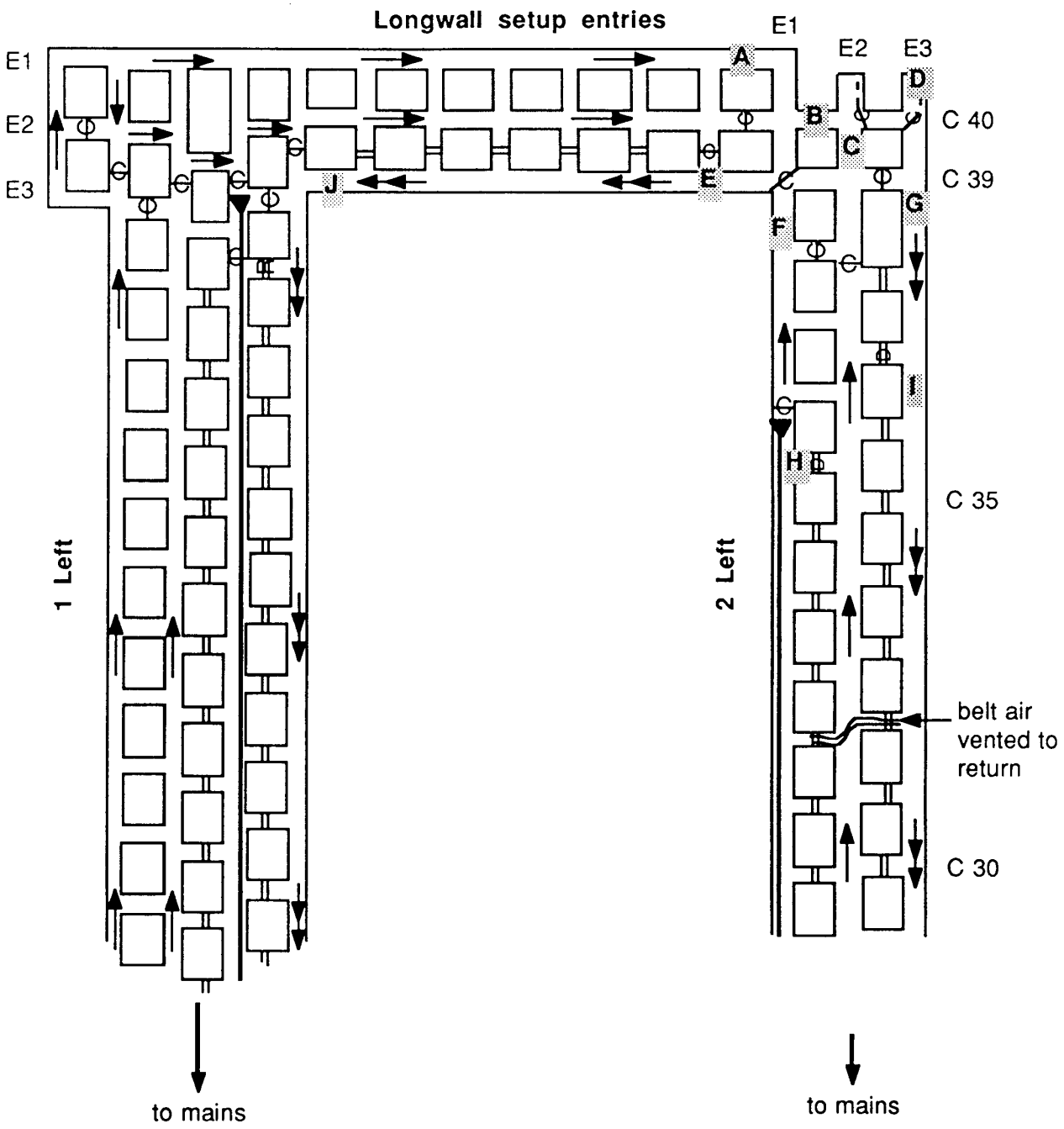

Figure 7: Points at which you would take methane and airflow measurements

Question H

Suppose you had taken methane and airflow measurements at the points shown in Table 1 below. Look at the airflow and methane readings in Table 1. Then study the map in Figure 7. If you were the examiner and you had this information, what would you do? (Select as MANY as you think are correct.)

37. Order everyone to walk out from the 2 Left section except for you and the 2 Left foreman. Tell the miners to report the conditions on the section when they get out.

38. Go to the power box. Knock the power to the entire 2 Left section. Then make sure that everyone is out of the mine.

39. Report what you have found. Call out to the surface on the mine pager which is located at the belt tailpiece just inby the belt check curtain in #1 entry in 2 Left.

40. Go to the pager at the belt tailpiece. Carefully disconnect the wires to the pager so no calls can come in.

41. After making sure the power is knocked and everyone is out of 2 Left section, go to the cutthrough, hang a curtain across it, and leave the section.

Point	% Methane	Air Flow cfm
A	0.15	36,000
B	0.15	20,000
C	2.50	20,000
E	0.15	15,700
G	1.30	43,000

Table 1: Methane and airflow readings at five points shown on the map in Figure 7

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

Question I

When you send the miners out from 2 Left section and when you and the foreman leave, what route should you take? (See Figure 7.) (Choose only ONE unless you are directed to “Try Again!”)

42. Both the miners and you should go out the 2 Left #2 entry because it is the intake air course and is the designated primary escape route for 2 Left section.

43. You should send the miners out the 2 Left #2 entry, but you and the foreman should leave by going out the intake air entry in the setup entries. That way you can warn the miners on the 1 Left section.

44. You should tell all the miners to leave by traveling through the #1 setup entry and going over to 1 Left section. You and the foreman should leave by the same route.

45. The best route out is through the 2 Left #3 entry because this is the shortest way to the outside and because the #3 entry is furthest from the high methane level in the #1 entry.

Question J

When a cutthrough from one section to another section is left open, as happened in this problem, why is it important to take airflow readings in the intakes as well as the returns before changing the ventilation? (Choose only ONE unless you are directed to "Try Again!")

46. It is not important. Accurate measurements in the returns for both sections are all that is needed.

47. The changes in airflow in the returns of the two sections may change very little or not change after the cutthrough. But the airflow in the intakes of the two sections may change a lot.

48. When the cutthrough takes place, the air from one section may be wetter or dryer than from the other section. This mixture of wet and dry air can produce mixtures of blackdamp and fire damp.

49. Air measurements need to be taken in the intakes of the two sections, only if there are changes in the airflow readings in the returns after the cutthrough.

Question K

Which rule is important when cutting through from one section to another? (Choose only ONE unless you are directed to “Try Again!”)

50. Never cut through without first building a permanent stopping on each side of the place where the cutthrough is to be made.

51. At the time of the cutthrough use curtains or other temporary stoppings to keep the ventilation of the two sections separate just as they were before the cut was made.

52. After the cutthrough, take airflow readings in the returns and the intakes of both sections. If there are any changes in airflow, hang a curtain in the cutthrough to keep the air from the two sections from mixing. Otherwise leave the cut open.

53. Just after the cutthrough, take air readings in the intakes and returns. Then, try to regulate the air in the returns of both sections so there is no flow of air in the cut that connects the two sections.

Question L

Think about this entire exercise. Review the maps. Remember there are two sections working and that each has two shifts. And remember that there are maintenance personnel involved as well.

On the answer sheet describe the mining and communication procedures that should have been used when cutting through from one section to the other to make sure the cutthrough proceeded safely (to prevent ventilation problems, accidents or other problems).

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 37. 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 51 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 Cutthrough Ventilation Arrangements

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.

Question A (Choose only ONE unless told to "Try Again!")

1. [ ]

2. [ ]

3. [ ]
   [ ]

4. [ ]
   [ ]

Question B (Choose only ONE unless told to "Try Again!")

5. [ ]

6. [ ]

7. [ ]

8. [ ]

9. [ ]

Question C (Choose only ONE unless told to "Try Again!")

10. [ ]

11. [ ]

12. [ ]

13. [ ]

14. [ ]

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

15. [ ]

16. [ ]

17. [ ]

18. [ ]
    [ ]

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

19. [ ]

20. [ ]

21. [ ]

22. [ ]

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

23. [ ]
    [ ]

24. [ ]
    [ ]

25. [ ]

26. [ ]
    [ ]

Question G (Choose as MANY as you think necessary, but no more than four.)

27. Point A [ ]

28. Point B [ ]

29. Point C [ ]

30. Point D [ ]

31. Point E [ ]

32. Point F [ ]

33. Point G [ ]

34. Point H [ ]

35. Point I [ ]

36. Point J [ ]

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

37. [ ]
[ ]
[ ]

38. [ ]
[ ]
[ ]

39. [ ]
[ ]
[ ]

40. [ ]
[ ]
[ ]

41. [ ]
[ ]
[ ]
[ ]

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

42. [ ]
[ ]
[ ]
[ ]

43. [ ]

44. [ ]
[ ]
[ ]
[ ]

45. [ ]

Question J (Choose only ONE unless you are told to "Try Again!")

46. [ ]
[ ]

47. [ ]
[ ]
[ ]
[ ]

48. [ ]
[ ]

49. [ ]

Question K (Choose only ONE unless you are told to "Try Again!")

50. [ ]

51. [ ]
[ ]

52. [ ]

53. [ ]

Question L

Describe the mining and communication procedures that should have been used when cutting through from one section to the other to prevent ventilation problems and accidents. Write on this page. Use the back of the page if you need more space.

Finding your score

Number of “Correct” answers you colored in	=	(1) _____
37 minus the number of incorrect answers you colored in	=	(2) _____
Add blanks one and two to get your total score	=	(3) _____

The highest possible score is 51.

The lowest is zero.

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.

D is the intake. The return for 2 Left is labeled **E**. Try again!

Correct! Do the next question.

A and **B** are the 2 Left intake and return. The setup entries are marked with a **C**. Try again!

The black dots mark the splitting of air at the intakes and returns. The overcasts are not shown. Try again!

Try again!

Correct! The intake and return flow must be the same. Do the next question.

Try again!

Try again!

Try again!

Try again!

Try again!

Try again!

Correct! Do the next question.

Try again!

Try again!

Try again!

Try again!

Correct! The only way to know for sure is to make air measurements after the cutthrough is completed. Do the next question.

Correct! But, you must measure the airflow to be certain.

There may be changes in airflow elsewhere.

The changes can be much larger.

It is unsafe and illegal to leave the cutthrough open.

Ten minutes after you put the curtain up, an explosion occurs on 2 Left. It kills you and all the other miners on the section. Try again!

Correct! Now you have to decide where to take the readings. Do the next question.

He says, "Sure! It's been open all night and the ventilation is OK" Try again!

You leave it open. An hour later there is an explosion on 2 Left. It kills all the miners on the section. Try again!

methane = 0.15 %, airflow = 36,500 cfm

methane = 0.15 %, airflow = 20,000 cfm from 1 Left to 2 Left.

methane = 2.50 %, airflow = 23,000 cfm

methane = 1.40 %, airflow = 12,000 cfm

methane = 0.15 %, airflow = 15,700 cfm

methane = 2.50 % airflow = 18,000 cfm

methane = 1.30 % airflow = 43,000cfm

methane = 12.00 %, airflow = 5, 000 cfm

methane = 1.30%, airflow = 43,000cfm

methane = 0.15%, airflow = 16,000cfm

Correct! A methane explosion is possible at any moment. There may be explosive levels of methane in the primary and secondary escapeways. No equipment should be operated.

Correct! You knock the power. Your spotter shows 2.3% methane at the power box. Meanwhile, the 2 Left foreman makes a headcount and sends all the miners out.

When you do this, there is a spark. The methane ignites. You and the foreman are killed in the explosion. Some of the miners walking out are also killed and others are badly burned.

When you do this, there is a spark. The methane ignites. You and the foreman are killed in the explosion. Some of the miners walking out are also killed and others are badly burned.

Correct! All power has been knocked. All miners are out. When you close off the cutthrough, the ventilation for the two sections should soon return to normal. The high levels of methane in the intake and neutral air entries of 2 Left should be reduced.

The #2 entry is the designated primary escapeway, but it is not a good choice in this situation. Try again!

This is not the best choice. There is a better alternative. Try again!

Correct! This is the safest route. Methane is present in the explosive range in much of the 2 Left entries. Leaving this way would expose miners to a long and dangerous trip. However, the air in the setup entries and 1 Left is OK. Do the next question.

This is not a good choice. There is a better alternative. Try again!

Try again!

Correct! The flow in one intake may increase and the flow in the other intake decrease by a large amount, as happened in this problem. With a decrease in intake airflow in 2 Left in this problem, dangerous levels of methane built up along the rib of the longwall panel. Do the next question.

Blackdamp is oxygen deficient air. Firedamp is methane. Neither can be produced by mixing wet and dry air. Try again!

Try again!

This is not practical and is not required by law. Try again!

Correct! This is practical and easy to do. It is also required by law. Do the next question.

This is an improper and dangerous procedure. Try again!

This is an improper and dangerous procedure. Try again!