

Trailing Cable Electrical Problem

Instructor's Copy

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&

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Introduction

This instructor's package contains all the materials needed to use the exercise². It tells how to use the exercise, presents the objectives, the question and feedback cards, and discussion notes to be used following 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 documents.

Type:	Problem book with question and feedback pages with a paper and pencil answer sheet
Audience:	Mine electricians
Length:	Seven questions (can be completed and discussed in a total of 45 minutes)
Skills:	Diagnosing basic electrical problems that cause an A.C. circuit breaker to trip repeatedly Recognizing and selecting safe work practices when trouble shooting and correcting trailing cable problems
Location:	Underground coal mine
Problem:	Sam, the shuttle car operator, has dumped two buggies of coal and is going back to the miner for another when the breaker trips, stopping the buggy. The breaker is reset, but begins to trip repeatedly. Sam and the section electrician must use safe work practices to find and correct the electrical problem.

² You can obtain a copy of the problem booklet and the answer sheet 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 annual refresher class.
2. Using the problem booklet, work the exercise. Then score your answers using the instructions on the bottom of the answer sheet.
3. Read the "Instructors Discussion' Notes" for the exercise.
4. Become thoroughly familiar with the problem before class so you can present it effectively.
5. When you present the exercise to the class:
 - Have class members work in groups of 3 or 4 persons
 - Give every person an answer sheet and a pencil.
 - Give each person a problem booklet.
 - Go over the instructions for doing the exercise with the whole group.
 - Have the miners in each small group work through the exercise with each person marking his or her answers on their own answer sheet.
 - When the class members finish, have each person figure up their score using the instructions on the answer sheet.
 - When everyone has finished, ask class members to discuss the merits of each answer. Add your own ideas.

Performance Objectives for Trailing Cable Exercise

Objective number	Capability verb(s)	Description of required performance and conditions under which it is to occur
1. ED ³	Recognize Diagnose	Electrical problems that may trip a shuttle car circuit breaker
2. ED	Locate	The position of the electrical problem in the cable, shuttle car, or ground monitor
3. ED/SW	Select Recognize	Safe and effective work practices when troubleshooting electrical equipment
4. ED	Infer Hypothesize	The nature of an electrical problem given information about how the circuit breaker trips, the status of the undervoltage release (UVR) light, and status of the ground monitor

³ Skill and knowledge domain abbreviations:
ED electrical diagnostics
SW safe work practices

Instructor's Discussion Notes

Use the information presented here and in the problem booklet, 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 if the miners look at their problem booklets during the discussion. 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 feedback pages in the problem booklet.

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.

The last portion of the discussion notes includes a description of the Femco Tone-Type ground monitor and a wiring diagram of the power center. It is helpful to duplicate copies of these notes and the diagram for use during the discussion period.

Question A - The correct answers are 2 and 3. Sam could tell the boss (1), but a circuit breaker that trips once is usually not a cause for immediate concern.

Question B - The correct answer is 4. Something appears to be wrong with the shuttle car and Sam has checked the ground monitor (5) and not found anything to cause the breaker to trip. Problems usually don't fix themselves and the boss should be alerted to the possibility of a breakdown. Sam should not take it upon himself to ask the electrician (6) to work on his buggy.

Question C - The correct answer is 8. Sparky could visually inspect the cable (7), but unless the fault was obvious this might not accomplish anything. Calling outside for a new cable (9) would be premature, for the cable has not been identified as being the problem. An energized cable (10) should never be handled, particularly if it is suspected to have a fault.

Question D - The correct answer is 11. When a circuit breaker trips under a ground fault condition, it is not usually a violent trip, while a phase-to-phase fault would be (15). Since the "trip" indicator light and the "latch trip" light did not come on, this would eliminate the

ground monitor (12) and the ground conductor (13). Sam would have noticed if a single phase condition existed (14), because the buggy would have lost considerable power.

Question E - The correct answer is 19. If the ground monitor (16) or the ground conductor (17) were the cause of the problem, the circuit breaker could not be reset because the contacts GM (see diagram) would probably not be closed. The problem could possibly be in the plug (18); but this would probably not be an intermittent trouble, because this part of the cable is usually not moved during mining operations.

Question F - The correct answers are 20 and 22. The circuit should be locked and tagged out anytime the plug is removed from the power center. This should be done even though the electrician expects to remain nearby the power center (20). Since the circuit breaker can be set immediately after it trips, this eliminates an overload (21) due to the thermal characteristics of the breaker. If Sam tried to operate the buggy, he would find that he couldn't, because the breaker is tripped (23).

Question G - The correct answers are 24, 26 and 27. Cutting open a doubtful splice might find the problem (25), but then again it might only create more work if the splice is sound. Looking for a "hot spot" in the cable is a useful troubleshooting technique, but a ground fault would not cause heat to build up because the breaker would trip immediately when the problem occurs.

The Femco Monitor

The Femco Tone-Type ground monitor has three indicator lights: a yellow "tune" light, a red "trip" indicator, and a red "latch trip" light.

The yellow "tune" light is on when the signal from the ground monitor transmitter is sent out through the phase conductors and is returned through the ground conductor. This indicates that the ground is continuous and allows the ground monitor to "pick up". The monitor should be adjusted so that the yellow light is at maximum brightness.

The red "trip" light is on when the signal being sent out by the transmitter is not returned to the unit. An open grounding conductor would give this indication, and if the monitor is adjusted properly, a single phase condition would do the same thing. This condition would cause the breaker to trip, or keep it from being reset once it has tripped.

The red "latch trip" light is on whenever the "trip" light is on, and it stays on when the red "trip" light goes off. This prevents the circuit breaker from being reset, even when the grounding conductor is good and the yellow "tune" light is on. In order to turn off the "latch trip" light, the "latch reset" button must be pushed. Now the circuit breaker can be reset.

If all three of the indicator lights are on, this indicates that the ground monitor is incorrectly adjusted.

The control circuit for the power center is wired as shown in Figure 1.

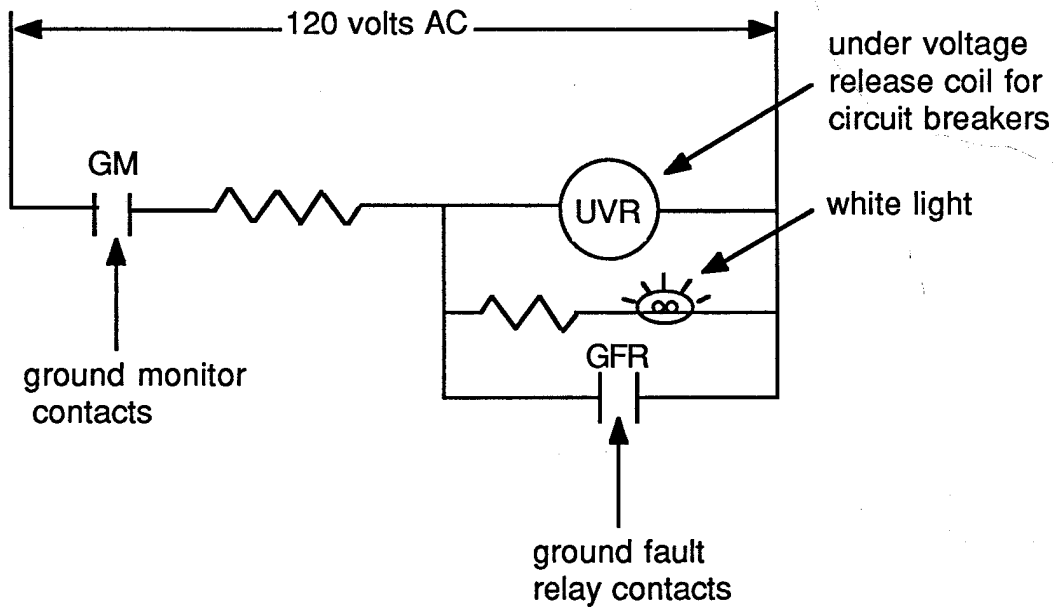


Figure 1: Control circuit for a power center with a Femco ground monitor

When the ground conductor is found to be good by the monitor, the contacts GM closes and connects the circuit breaker coil to 120 Volts and the white light comes on. This allows the circuit breaker to be turned on. When a ground fault occurs, the GFR contacts close. This removes the 120 Volts from the UVR coil and the white light. The circuit breaker trips and the ground fault stops. The GFR contacts open and restores the 120 Volts to the UVR and the white light. This is what causes the white light to blink out during a ground fault.

Appendix A: Problem Booklet

Duplicate this copy of the problem booklet for use in your classes. It should be **printed on one side only**. 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. The telephone number for this agency is listed in the footnote on page three of this document.

Trailing Cable Electrical Problem

Problem Booklet

Instructions

Read the information on this page and the next page. Then you will be asked 7 questions about this problem. Each question is on a separate page. Work through the exercise one page at a time. Don't jump ahead, but you may look back to earlier questions and your answers.

When you have finished reading the first two pages, read Question A on the third page. Think about the situation. Then select as many answers as you think are correct for that question by circling their numbers on the answer sheet. When everyone in your group has selected their answers to Question A, turn the page and look at the feedback page for that question. Then talk about the answers.

The next question has only one right answer. For question B choose the best answer to that question. Continue on and do the remaining questions in the same manner as the first two, following the directions for each question. When you finish you will learn how to score your performance.

Trailing Cable Electrical Problem

Background

This is a 3-section mine with a seam height of 60 inches.

This mine utilizes 550 volt 3 phase equipment and has continuous miners. Femco ground monitors are used.

The mine is mostly dry, but an occasional mud hole is not unusual.

Sam operates one of the shuttle cars and Sparky is the electrician.

The equipment is well maintained, but is getting old and breakdowns are beginning to cut into production.

Problem

Sam, the shuttlecar operator, has dumped two buggies of coal and is going back to the miner for another when the breaker trips, stopping the buggy.

Question A

What should Sam do now? (Select ALL the correct answers.)

1. Tell the boss and ask him to get the electrician.
2. Check the ground monitor.
3. Reset the breaker.

When you have marked your answer(s) on the answer sheet, turn the page and look at the Question A feedback.

Question A Feedback

1. [This is probably not necessary at this time.]
2. [Correct! The ground monitor checks good.]
- 3 [Correct!]

After you have thought about these answers, do question B.

Question B

The breaker stays in and Sam makes two more runs. The buggy operates normally until the breaker trips again as he leaves the feeder. Sam resets the breaker. What should he do now? (Select only ONE answer.)

4. Tell the boss.
5. Check the ground monitor.
6. Notify the electrician that a problem exists.

When you have marked your answer on the answer sheet, turn the page and look at the Question B feedback.

Question B Feedback

- 4. [Correct! The boss tells Sam that he'll send the electrician to
[trouble-shoot the problem.]
- 5. [Not a bad idea but you did this before and it checked out.]
- 6. [You need to do something else.]

After you have thought about these answers, do question C.

Question C

On the next trip, the breaker trips as Sam approaches the miner. He sets the parking brake and goes for the boss. Sam tells the boss that it's not the ground monitor and he doesn't know what the problem is. The boss has the buggy moved out of the roadway and tells Sparky, the electrician, to check it out. Sparky can't find any problem. He finds the ground monitor is good, and the breaker sets properly. Now what should Sparky do? (Select only ONE answer.)

7. Walk the cable.
8. Tell Sam to operate the shuttlecar while he (Sparky) stays at the power center.
9. Call outside for a new cable.
10. Tell Sam to flex the cable at all the splice points while he (Sparky) monitors the energized cable at the breaker.

When you have marked your answer on the answer sheet, turn the page and look at the Question C. feedback.

Question C Feedback

- 7. [This is not the best choice at this time.]
- 8. [Correct! The way the breaker trips could help identify the problem.]
- 9. [This would be premature at this time.]
- 10. [This is extremely dangerous. The cable could blow up. Sam could be
[burned or electrocuted.]

After you have thought about these answers, do question D.

Question D

When Sam operates the shuttle car, the breaker trips while Sparky is at the power center. It sounds similar to the way the breaker trips when the "test" button is pushed on the ground monitor. The trip indicator light does not come on. This indicates that: (Select only ONE answer.)

11. A phase-to-phase fault is not likely.
12. The ground monitor is bad.
13. The ground conductor is: open.
14. A single phase condition exists.
15. A phase-to-phase fault is probable.

When you have marked your answer on the answer sheet, turn the page and look at the Question D feedback.

Question D Feedback

- 11 [Correct! A phase-to-phase fault would cause the breaker to trip violently.
- 12. [This is a possibility,! but the trip light is not on.]
- 13. [This is a possibility, but the trip light is not on.]
- 14. [Not likely, since Sam did not report any loss of power or problem of
[starting the buggy when the breaker was reset.]
- 15. [This is not likely since the breaker did not trip violently.]

After you have thought about these answers, do question E.

Question E

Sparky resets the breaker, but it trips immediately. He notices that the UVR light blinks out and comes back on after the breaker trips. Now what should he check? (Select only ONE answer.)

- 16. The ground monitor.
- 17. The ground conductor.
- 18. The plug.
- 19. The phase conductors.

When you have marked your answer on the answer sheet, turn the page and look at the Question E feedback.

Question E Feedback

- 16. [This is not a possibility.]
- 17. [This is not a possibility.]
- 18. [This is not the best choice.]
- 19. [Correct! A ground fault could give these symptoms.]

After you have thought about these answers, do question F.

Question F

Sparky should know that the first steps in trouble-shooting ground faults are to: (Select ALL the correct answers.)

20. De-energize, tag and lock-out the circuit.
21. Check the trip settings on the breaker.
22. Pull the plug and read from phase to ground with an ohmmeter.
23. Have Sam tram the buggy around to try and determine the problem.

When you have marked your answer on the answer(s) sheet, turn the page and look at the Question F feedback.

Question F Feedback

- 20. [Correct! This is an important safety task that should not be skipped.]
- 21. [This will not help.]
- 22. [Correct! This will show if a phase to ground fault exists.]
- 23. [This will not help identify the problem.]

After you have thought about these answers, do question G.

Question G

Sparky has determined that a phase to ground fault exists. What are the next steps he should take in pinpointing the fault in the cable? (Select ALL the correct answers.)

24. Use a "cable hound" on the cable.
25. Cut open a splice that looks like it is in bad condition.
26. Look for a splice that is being strained by a sheave wheel or the corner of a block.
27. Watch the ohmmeter while Sam flexes the cable.
28. Check for "hot spots" in the cable.

When you have marked your answer(s) on the answer sheet, turn the page and look at the Question G feedback.

Question G Feedback

- 24. [Correct!]
- 25. [This may work, but is not the best choice.]
- 26. [Correct! This is a good place to start checking.]
- 27. [Correct! This will show an intermittent problem.]
- 28. [The ground fault would not last long enough to heat the cable.]

End of Problem.

Now use these feedback pages to score your answer sheet.

Appendix B: Answer Sheet

This is the answer sheet. Unlike the problem booklet, the answer sheet is consumable. You will need one new answer sheet for each person in your class.

Trainees should work the exercise in groups of three or four persons. Each person should have his or her own answer sheet.

After everyone in the small group has marked their answer on their own answer sheet, all the miners in the small group should look at the feedback for the answers to the question and briefly discuss this information. When the discussion is completed, the group should continue on and do the remaining questions in the same way

Trailing Cable Electrical Problem Answer Sheet

Mark your answers for each question by circling the appropriate numbers on this answer sheet.

Question A	(Circle ALL correct)	1	2	3		
Question B	(Circle ONE)	4	5	6		
Question C	(Circle ONE)	7	8	9	10	
Question D	(Circle ONE)	11	12	13	14	15
Question E	(Circle ONE)	16	17	18	19	
Question F	(Circle ALL correct)	20	21	22	23	
Question G	(Circle ALL correct)	24	25	26	27	28

Finding your score

Number of "Correct" answers you marked = (1) _____

17 minus the number of incorrect answers you marked = (2) _____

Add the values in blanks (1) and (2) to get your total score = (3) _____

Highest possible score = 28.

Lowest possible score = 0