Tipple Heater Exercise

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 and the scoring key. 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. This exercise is based on the 1987 National Electric Code. Copies should be available for use during this exercise. Hand held calculators would be helpful, although not required.

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
Audience:	Mine electricians (Surface or underground, metal or non-metal)
Length:	Eleven questions (25 minutes for administration plus 25 for discussion)
Skills:	Calculation of the power requirements for a tipple electrical heater given the heater's voltage and the current capacity Selection of the appropriate size conductors and fuse disconnects for the heater given overcurrent requirements, available wire, known insulation material on the wire, and given a main power source with known current and electrical potential Facility in the use of tables, charts, and nomographs in the National Electrical Code handbook for solving electrical wiring problems
Location:	Tipple at a surface or underground coal mine
Problem:	You are a qualified electrician with 5 years of experience. Below freezing weather has been causing problems on the tipple. The tipple boss wants an electrical heater installed immediately. Your supervisor, the chief electrician, is too busy to help. He tells you to take care of it. The company electrical engineer is on vacation. You must determine the power and wiring requirements for the heater, and you must work within the National Electrical Code standards.

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

How to Use This Exercise

1. Look at the performance objectives. Decide if the exercise is relevant for your mine training class.

2. Work through the exercise with the developing pen and score your responses.

3. Read the master answer sheet for the exercise. Look at all the answers.

4. Read the "Instructor's Discussion Notes" for the exercise.

5. Become thoroughly familiar with the problem so that you can present it to your class without reading it.

6. When you present the exercise to the class:

   - Give each person an exercise booklet, and each group of 3 to 5 one 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, encourage class members to discuss the merits of each answer. Add vour own ideas.

Performance Objectives for Tipple Heater Exercise

Objective number	Capability verb(s)	Description of required performance and conditions under which it is to occur
1. ECC[3]	Calculate	Current requirements for a resistor given the voltage and power rating
2. ECC	Calculate Convert	Current in a three phase circuit given the single phase current values, or the reverse
3. ECC/UH	Determine Calculate	The overcurrent protection factor required for a resistor with known current requirements given a copy of the National Electrical Code (NEC)
4. ECC/UH	Determine Estimate	For available type of conductor material, (copper, aluminum, etc.) the proper wire size for the power supply to an electrical resistor with known current requirements and known insulation material, by reference to the NEC
5. ECC/UH	Select Determine	Proper current capacity fuse disconnect size given a resistor of known current and power requirements, and a power supply source with known voltage and current by reference to NEC tables and charts
6. ECC/UH	Select	Minimum conductor size for the feeder wire from the main power supply line with known current and potential to the fuse disconnects for a resistor with known power requirements by reference to NEC tables and charts
7. UH	Discriminate Select Interpret	Among various tables, charts, and sections of the NEC, those particular sections that are relevant for calculating conductor size, fuse disconnect size, etc. given a typical problem involving a resistor with known power requirements and a supply source with known current and potential

[3] Skill and knowledge domain abbreviations:
ECC = electrical concepts and calculations
UH = use of standard handbook charts, tables, nomographs, etc.

Master Answer Sheet for Tipple Heater Exercise

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

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

1. [This would take a long time. He may have locked his office when he left.]
   [Try again!]

2. [This would take a long time since you don't have the phone number.]
   [Try again!]

3. [Good idea, but remember this is the only heater in the warehouse. Try again!]

4. [Correct. It will only take a minute to make the necessary calculations. Do the]
   [next question.]

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

5. [You might be able to use another version of this formula, but you don’t know]
   [the resistance of the heater. Try again!]

6. [Correct. The current equals the power divided by the voltage. Do the next]
   [question.]

7. [This is the basic Ohm's law formula which is useful in many situations. But]
   [you don't know the resistance. Try again!]

8. [This is a method of calculating power in a circuit, but it won't provide the]
   [current. Try again!]

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

9. [Correct. 20,000W + 480V = 41.7 amps. Do the next question.]

10. [Check your decimal point and try again!]

11. [Make sure you are using the correct formula and data. Then try again!]

12. [Make sure you are using the correct formula and data. Then try again!]

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

13. [Try again!]
[ ]

14. [Correct. With three conductors carrying the current instead of two, the three-]
[phase value will be less than the single-phase calculation. Do the next]
[question.]

15. [Try again!]

16. [Try again!]

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

17. [Remember the actual current will be LESS than the single-phase]
[calculation. Try again!]

18. [The number 1.414 is used to convert between RMS and peak voltages]
[and currents. Try again!]

19. [Remember the actual current will be LESS than the single-phase]
[calculation. Try again!]

20. [Correct. 1.73 is the square-root of 3 and is used to make many three-phase]
[calculations. Do the next question.]

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

21. [Correct. 41.7 amps/1.73 = 24 amps. Do the next question.]

22. [Re-check the conversion value and try again!]

23. [Remember, the 3-phase current will be less than the single-phase value.]
[Try again!]

24. [Remember, the 3-phase current will be less than the single-phase value.]
[Try again!]

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

25. [An early section of Article 220 lists the requirements for 'Computation of Branch Circuits' and covers continuous and noncontinuous loads. Check this section and try again!]

26. [An early section of Article 220 lists the requirements for 'Computation of Branch Circuits' and covers continuous and noncontinuous loads. Check this section and try again!]

27. [An early section of Article 220 lists the requirements for 'Computation of Branch Circuits' and covers continuous and noncontinuous loads. Check this section and try again!]

28. [Correct. Article 220-3(a) covers calculation of continuous and non-continuous loads and requires the circuit to be rated at 125% of the continuous load. Article 424-3(b) on heating equipment makes the same requirements. Do the next question.]

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

29. [The value 125% means to multiply by 1.25. Check your math and try again!]

30. [The value 125% means to multiply by 1.25. Check your math and try again!]

31. [Correct. 125% means to multiply by 1.25. 1.25 x 24 amps = 30 amps. Do the next question.]

32. [The value 125% means to multiply by 1.25. Check your math and try again!]

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

33. [Table 310-13 gives information on conductor applications and insulation, but is not used to select conductor size. Try again!]

34. [Table 310-22 is used for three conductor cable. We are using three single conductors in conduit. Try again!]

35. [Table 310-23 is used for conductors supported on a messenger cable. Try again!]

36. [Correct. Table 310-16 is used for general purpose installations. Do the next question.]

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

37. [#14 gauge wire is not heavy enough. Check the chart and try again!]

38. [#12 gauge wire may seem like the proper size, but check the footnotes and]
[try again!]

39. [Correct. The footnotes specify special current values for THHN insulation.]
[Do the next question.]

40. [#8 gauge wire would work, but is heavier than needed here. Check the chart]
[and try again!]

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

41. [Correct. Article 240-21, exception #2, allows a smaller conductor to be]
[tapped onto a larger conductor provided that it is not longer than 10 feet,]
[and is terminated in an overcurrent device that protects that conductor.]
[**End Of Problem**.]

42. [This size conductor would be acceptable, but is larger than necessary.]
[Check section 'B' of Article 240 and try again!]
[ ]

43. [This size conductor would be acceptable, but is larger than necessary.]
[Check section 'B' of Article 240 and try again!]

44. [This size conductor would be acceptable, but is larger than necessary.]
[Check section 'B' of Article 240 and try again!]

Finding your score

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

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

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

Highest possible score = 44

Lowest possible score = 0

Discussion Notes for Tipple Heater Exercise

Use the information presented on the master answer sheet, your own ideas and experience, and that of the electricians in your class to discuss the exercise after it is completed. Group discussion can help strengthen knowledge and skills, correct errors, and relate the exercise content to the experiences of the trainees. After they have worked the exercise, class members 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 the trainees think about and remember basic knowledge and skills they may someday need to deal with a similar problem. 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 trainees look at their problem booklets. This allows you to lead the group through the exercise and to discuss all the answers to each question. Information about why particular answers are correct or incorrect is given on the master answer sheet.

References

Morley, L. A., et. al. (1977). Coal mine electrical system evaluation. Volumes 1-7. University Park, PA: Pennsylvania State University. (USBM OFR 61-78).

Morley, L. A. (1982). Mine power systems. University Park, PA: Pennsylvania State University, Department of Mineral Engineering. (USBM OFR 178-82).

National Electrical Code 1987. (1987). Quincy, MA: National Fire Protection Association.

Stanek, E. K., et al. (1979). Mine electrical power systems. Transients protection, reliability investigation, and safety testing of mine electrical power systems. Morgantown, WV: West Virginia University, Engineering Experiment Station. (USBM OFR 6-81).

Scoring Key for the Tipple Heater Exercise

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

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
I	33	34	35	36*
J	37	38	39*	40
K	41*	42	43	44

[4] This page may be duplicated and used as an overhead transparency.

Appendix A: Problem Booklet

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

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

Tipple Heater Exercise

Problem Booklet

Instructions

Read the problem situation described on the next page. Next, answer each of the 11 questions. Do them one at a time. Don't jump ahead, but you may look back to earlier questions and answers. Select the one best answer to each question.

After you have selected your 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. If you select a wrong answer to a question, you will be told to "Try again!" Then select and color in another answer for that question. When you have finished, you will learn how to score your performance.

Now, turn the page and begin the exercise.

Background

You are a qualified mine electrician with 5 years experience at this mine. It is late October and the weather has been very cold for this time of year.

The company electrical engineer is on vacation and is not expected back for several days. Because of this, the chief electrician, your boss, is extremely busy.

Problem

The tipple boss talked to you a few days ago about installing a heater to eliminate some freezing problems that have occurred when the tipple wasn't running. You had mentioned this to your boss, but he didn't do anything about it. Today the tipple boss says he needs the heater installed immediately. You call your boss again and he tells you to go ahead and put it in, but make sure it's done according to code! He doesn't have time to help you, so you're on your own!

NOTE: This problem is based on the 1987 National Electrical Code and requires a copy of that document be available. A hand-held calculator would also be helpful.

Question A

In the warehouse you find only one heater. The label has been damaged and most of the information is missing. You can read the heater voltage and power rating:

480 volts 3-phase 20KW

In order to install this heater, you must know the current requirements before you can select wire size and overcurrent devices. How would you determine the current requirements for the heater? (Choose only ONE unless you are told to "Try Again!")

1. Go to your boss' office and look it up in a catalog.

2. Call the manufacturer.

3. Look on another heater label.

4. Use the power formula and calculate the required power.

Question B

You have decided to calculate the heater current. Which formula would you use? (Choose only ONE unless you are told to "Try Again!")

5. $P=I^2 \times R$

6. $I=P/E$

7. $E=I \times R$

8. $P=E^2/R$

Question C

You decide to use the power formula to calculate the current required by the heater. The power is 20KW and the voltage is 480V. What is the current? (Choose only ONE unless you are told to "Try Again!")

9. 41.7 amps

10. 4.17 amps

11. 3.6 amps

12. 36 amps

Question D

The current you have calculated is the amount that would be found in a single-phase circuit. How will the actual 3-phase current in the heater differ from the single-phase calculation? (Choose only ONE unless you are told to "Try Again!")

13. More than the single-phase calculation.

14. Less than the single-phase calculation.

15. About the same as the single-phase calculation.

16. Three times as much as the single-phase calculation.

Question E

To calculate the actual current in each phase of the 3-phase circuit, you would: (Choose only ONE unless you are told to "Try Again!")

17. Multiply the single-phase value by 1.414

18. Divide the single-phase value by 1.414

19. Multiply the single-phase value by 1.73

20. Divide the single-phase value by 1.73

Question F

Since the single-phase current calculated earlier was 41.7 amps, what will the actual 3-phase value be? (Choose only ONE unless directed to "Try again!")

21. 24 amps

22. 29 amps

23. 72 amps

24. 59 amps

Question G

You now know the actual current required by the heater. The next step is to decide what type and size overcurrent protection should be used. While in the warehouse you find a 3-phase fused disconnect suitable for this application. The National Electrical Code has requirements that continuous loads (those that can operate for more than three hours) must be connected to a circuit rated higher than the actual current required by the load. Article 220 of the Code requires the circuit to be rated at: (Choose only ONE unless you are told to "Try Again!")

25. 150% of the continuous value.

26. 200% of the continuous value.

27. 115% of the continuous value.

28. 125% of the continuous value.

Question H

You can now determine the proper fuse size to use for overcurrent protection of the heater circuit. What amperage fuse is needed? (Choose only ONE unless you are told to "Try Again!")

29. 34 amps

30. 42 amps

31. 30 amps

32. 3000 amps

Question I

The next step in installing the heater is to select the proper conductor size. Wire available at the mine is single conductor copper with type THHN insulation. This will require installation in conduit. You now turn to Article 310 in the National Electrical Code, "Conductors For General Wiring", to select the correct wire size. Which chart would you use: (Choose only ONE unless you are told to "Try Again!")

33. Table 310-13

34. Table 310-22

35. Table 310-23

36. Table 310-16

Question J

Using the tables in Article 310 can be tricky because of the many special conditions and exceptions. Carefully read the table and select the proper wire size. (Choose only ONE unless you are told to "Try Again!")

37. #14

38. #12

39. #10

40. #8

Question K

You now seem to have everything you will need to install the heater. At the tipple you begin your work and find the only convenient place to get power is a circuit rated at 300 amps. You know that the wire you have brought with you will not carry that much current. The fused disconnect can be mounted close to the power source point, about 6 feet away. Article 240 of the Code covers Overcurrent Protection and contains several rules about tapping smaller conductors onto larger circuits. What is the smallest size wire that can be used between the fuses and the 300 amp circuit? (Choose only ONE unless you are told to "Try Again!")

41. #10

42. # 1

43. 300 MCM

44. #8

The heater can now be installed in the tipple. A couple of days later the tipple boss thanked you for your help and mentioned that by installing the heater, the tipple has been much easier to get started again after being shut down.

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 33. Write the difference in the second blank on the answer sheet.

3. Add the numbers on lines 1 and 2 to get your total score. The best possible score is 44.

Appendix B: Answer Sheet Blanks

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

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

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

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

Answer Sheet for Tipple Heater Exercise

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

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

29. [ ]

30. [ ]

31. [ ]
[ ]

32. [ ]
[ ]

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

33. [ ]
[ ]

34. [ ]
[ ]

35. [ ]
[ ]

36. [ ]
[ ]

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

37. [ ]

38. [ ]
    [ ]

39. [ ]
    [ ]

40. [ ]
    [ ]

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

41. [ ]
    [ ]
    [ ]
    [ ]

42. [ ]
    [ ]
    [ ]

43. [ ]
    [ ]

44. [ ]
    [ ]

Finding your score

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

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

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

Highest possible score = 44

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.

This would take a long time. He may have locked his office when he left. Try again!

This would take a long time since you don't have the phone number. Try again!

Good idea, but remember this is the only heater in the warehouse. Try again!

Correct. It will only take a minute to make the necessary calculations. Do the next question.

You might be able to use another version of this formula, but you don’t know the resistance of the heater. Try again!

Correct. The current equals the power divided by the voltage. Do the next question.

This is the basic Ohm's law formula which is useful in many situations. But you don't know the resistance. Try again!

This is a method of calculating power in a circuit, but it won't provide the current. Try again!

Correct. 20,000W + 480V = 41.7 amps. Do the next question.

Check your decimal point and try again!

Make sure you are using the correct formula and data. Then try again!

Make sure you are using the correct formula and data. Then try again!

Try again!

Correct. With three conductors carrying the current instead of two, the three-phase value will be less than the single-phase calculation. Do the next question.

Try again!

Try again!

Remember the actual current will be LESS than the single-phase calculation. Try again!

The number 1.414 is used to convert between RMS and peak voltages and currents. Try again!

Remember the actual current will be LESS than the single-phase calculation. Try again!

Correct. 1.73 is the square-root of 3 and is used to make many three-phase calculations. Do the next question.

Correct. 41.7 amps/1.73 = 24 amps. Do the next question.

Re-check the conversion value and try again!

Remember, the 3-phase current will be less than the single-phase value. Try again!

Remember, the 3-phase current will be less than the single-phase value. Try again!

An early section of Article 220 lists the requirements for 'Computation of Branch Circuits' and covers continuous and noncontinuous loads. Check this section and try again!

An early section of Article 220 lists the requirements for 'Computation of Branch Circuits' and covers continuous and noncontinuous loads. Check this section and try again!

An early section of Article 220 lists the requirements for 'Computation of Branch Circuits' and covers continuous and noncontinuous loads. Check this section and try again!

Correct. Article 220-3(a) covers calculation of continuous and non-continuous loads and requires the circuit to be rated at 125% of the continuous load. Article 424-3(b) on heating equipment makes the same requirements.
Do the next question.

The value 125% means to multiply by 1.25. Check your math and try again!

The value 125% means to multiply by 1.25. Check your math and try again!

Correct. 125% means to multiply by 1.25. 1.25 x 24 amps = 30 amps. Do the next question.

The value 125% means to multiply by 1.25. Check your math and try again!

Table 310-13 gives information on conductor applications and insulation, but is not used to select conductor size. Try again!

Table 310-22 is used for three conductor cable. We are using three single conductors in conduit. Try again!

Table 310-23 is used for conductors supported on a messenger cable. Try again!

Correct. Table 310-16 is used for general purpose installations. Do the next question.

#14 gauge wire is not heavy enough. Check the chart and try again!

#12 gauge wire may seem like the proper size, but check the footnotes and try again!

Correct. The footnotes specify special current values for THHN insulation. Do the next question.

#8 gauge wire would work, but is heavier than needed here. Check the chart and try again!

Correct. Article 240-21, exception #2, allows a smaller conductor to be tapped onto a larger conductor provided that it is not longer than 10 feet, and is terminated in an overcurrent device that protects that conductor. **End Of Problem**.

This size conductor would be acceptable, but is larger than necessary. Check section 'B' of Article 240 and try again!

This size conductor would be acceptable, but is larger than necessary. Check section 'B' of Article 240 and try again!

This size conductor would be acceptable, but is larger than necessary. Check section 'B' of Article 240 and try again!