

## **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.