NEC 2017

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PLAN REVIEW

STUDY GUIDE

ELECTRICAL INSPECTOR CERTIFICATION PROGRAM

PLAN REVIEW STUDY GUIDE

Electrical Inspector Certification Program

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Updated to the
2017 *NEC*

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TECHNIQUES FOR TESTING

People study for a variety of reasons. Some study to improve their understanding and grasp of their chosen field, but the vast majority study because they will be required to show their competence in a given subject. Competence is generally measured by test scores. Unfamiliarity with the specific subject is one of the main reasons for low scores. Another reason is, a person's performance is only a sample of his or her behavior at that point in time. In other words, test scores are not set in concrete, and you can improve your score by preparing better, improving your attitude, and understanding the best methods to use in test taking.

The easiest way to improve your test performance is to reduce your anxiety level. The study guides sponsored by the International Association of Electrical Inspectors are designed to improve your understanding of how to find information in the *National Electrical Code*. The questions are designed to be similar to test formats you are likely to find in electrical inspector certification examinations. It should be understood that no effort is made to duplicate those questions exactly. To do so, would be nonproductive as questions are changed from time to time. Rather, the approach used in these study guides is to help you master locating information quickly and accurately. You can then master any test question. The refresher courses are available in three modules: *Electrical General Study Guide*, *One- and Two-Family Dwellings Study Guide*, and *Plan Review Study Guide*.

The goal of these courses is to ensure your best possible performance by understanding how to use the *National Electrical Code*® and thus reduce your anxiety level. The courses may be used for individual home study and are also ideally suited for an instructor/student classroom approach.

Examination for Certification

Methods to Improve Your Test Scores

1. *Prepare by studying.* The questions in this refresher course are designed to teach you how to find the rules quickly and efficiently. If you learn how to use the table of contents and index properly, you will find the material in a reasonably short period. This knowledge and confidence will help reduce your anxiety and raise your scores. Consistent study leads to a higher retention level than cramming just prior to the examination date. The ultimate goal is to become familiar with the use of the *NEC* and testing format.

2. *Arrive on time.* Make sure you allow plenty of time to arrive promptly, but not too early. Since nervousness is contagious, don't associate too closely

with the other examinees as you may pick up their anxiety level.

3 *Eliminate wrong answers.* If the test is multiple choice and you have four alternatives, the odds are 4 to 1 that you can guess the right answer. If you eliminate any two alternatives, your chances are increased to 50-50.

4 *Read directions carefully.* Many mistakes are made merely because the directions have been misunderstood. If, after reading carefully, you still are not sure, ask the proctor for clarification.

5 *Allow yourself enough time.* Based on the number of questions you have to answer, allot a specific amount of time for each question.

6 *Answer question first.* If the question has several alternatives, attempt to answer the question before you check the alternatives. In this way, you can evaluate your answer against the alternatives.

7 *Skip difficult questions.* If you are unsure of the answer or know that you are familiar with the material but don't have a ready answer, skip the question and go on to other material. Complete known questions then return to those you do not know. Chances are, your mind will subconsciously work out the answer so that it will be easier when you return to it.

8 *First choice is usually best.* If you pick an answer to a multiple choice question and have later reservations about the right answer, remember that your first choice is usually best. If on later evaluation you know you have made a mistake, by all means, change your answer.

9 *Read questions carefully.* Make sure you note keywords that might change the meaning of the questions. Note negative disclaimers such as, "which of the following are not...". A handy way to increase understanding is to underline keywords. This action tends to channel your thinking along the right path.

10 *Make sure you are comfortable.* If you have on too many clothes, remove some. Being too warm has a tendency to make you drowsy, which leads to a loss of concentration.

11 *Re-check your work.* The last thing you should do before handing in your paper is to recheck and make sure you have not made any clerical mistakes. Many times you will know the right answer, but lose points on your score because of a clerical error.

Study Plan

Familiarize yourself completely with the codebook. Until one is familiar with the *Code* to the extent that location of specific requirements is committed to memory, use of the index is the best way to find information. The index contains in alphabetical order a list of what is in the *Code*, telling where to find topics covered.

Even though you may know the answer to a question, follow this sequence to establish the answer:

1 Check the table of contents to find the proper code article.

2 Select key words from the question that will identify the code article and subject matter that will be used to find the requirements in the index.

For example, you have been asked to verify the size of a grounding electrode conductor for a 200 ampere AC service supplying a dwelling. The dwelling unit has a metal water pipe and the service-entrance conductors are 3/0, THWN, copper.

From the question, you can identify the subject of the question is a grounding electrode conductor. Specifically, you are being asked to determine the size. Additional keywords or subject matter are the *size of the service-entrance conductors* and the fact the dwelling is supplied by a *metal water pipe*.

Looking in the index, you find "Grounding electrode conductors" under which you will find "Sizing 250.30(A)(6)(a), 250.66 and 250.166." Scanning 250.30(A)(6) you quickly realize this is related to separately derived systems; so the next choice was 250.66 from the index. Section 250.66 is titled "Size of Alternating-Current Grounding Electrode Conductors."

The opening paragraph of 250.66 states the grounding electrode conductor cannot be less than given in Table 250.66 except as permitted in (A)–(C). Scanning 250.66(A)–(C), you find they are not applicable to the question; so Table 250.66 must be used.

Table 250.66 is based on the size of the service-entrance conductors; so in our case, we determine a 4 AWG copper grounding electrode conductor is required for an AC service supplied by 3/0 copper conductors.

3 If, in the index, you do not readily find the location of the requirements related to the question, scan the boldface titles of the appropriate sections in the body of the code to locate quickly the subject material.

The Table of Contents lists, in numerical sequence, the subjects covered by each chapter and each article. So it provides the article number, part number if applicable, and a page number that can be used to find a location to start scanning section and subsection titles. Experienced users of the *NEC* are generally familiar with the content of *NEC* articles and, therefore, often use the Table of Contents to find a page number as a starting point.

4 Using the above question, an experienced user of the *NEC* would know that grounding and bonding requirements are found in Article 250. Scanning the information in the *NEC* Table of Contents, we find the requirements for the "Grounding Electrode System and Grounding Electrode Conductor" are in Part III of Article 250, and they start on page 112. Scanning the boldfaced section and subsection titles starting on page 112, we find 250.66 "Size of Alternating-Current Grounding Electrode Conductors on page 115."

This study guide is divided into subject categories, and each category has several questions. Each question is followed by the procedure for finding the correct answer. Follow the procedures step by step to learn good work habits. The answers are listed in the back of the book. Do not look up the answers until you have completed work in the entire category.

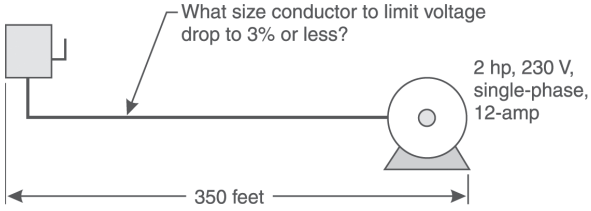
Remember, you are only short changing yourself by not following the step-by-step method of problem solving. The goal is to learn how to find code information in the most efficient manner.

This study guide is based on the *National Electrical Code*, 2017 edition.

Calculations

1 A 2-horsepower, 230-volt, single-phase, alternating-current motor is located 105 m (350 ft) from the service. What is the minimum size uncoated stranded copper conductor that is required to limit the voltage drop to 3 percent or less?

A. 12 AWG
B. 10 AWG
C. 8 AWG
D. 6 AWG



ANSWER _____

PROCEDURE TO ESTABLISH ANSWER
The question is about voltage drop for a motor circuit.

1. In Index, find "Motors" under which find "Current, full load. *see* Full-load current motors."
2. Under "Full-load current motors," find "Alternating current" under which find "Single-phase, Table 430.248."
3. In Table 430.248 find a 2-horsepower, 230-volt motor rated 12 amperes.
4. Using the voltage drop formula:
   VD = 2 KLI/cm
   VD = 2 x K factor x Length of run x I (amperage) cm (circular mils of wire)

   WHERE:
   VD = Volts Dropped. You then take the volts dropped and divide it by the voltage of the circuit or system, and the result is the percentage (%) of voltage drop.

A 3% voltage drop, for example
= 3% x 230 volts
= 6.9 volts

K = 12.9
cm = Circular mil area of conductor (Chapter 9, Table 8)
VD = 2 x K x L x I / cm

When transposed, the new formula shown below will give us the minimum size wire needed to permit a maximum of 3% voltage drop on the circuit.

cm = 2 x K x L x I / VD
cm = 2 x 12.9 x 350 x 12/6.9
cm = 108,360 /6.9
cm = 15,704 cm

5. In Index find "Conductors," under which find "Copper, Properties, Chap. 9, Table 8."

6. In Table 8, we find 10 AWG has 10,380 circular mils and 8 AWG has 16,510 circular mils. Therefore, based on the above formula, we select an 8 AWG copper conductor.

7. *VD = 2 x K x L x I / cm*
VD = 2 x 12.9 x 350 x 12
VD = 108,360/16,510
VD = 6.56 volts

8. VD = 6.56 volts ÷ 230 volts
VD = .028 (or 2.8% voltage drop)

The 8 AWG copper conductor will limit the voltage drop to 3% or less.

The correct answer is C.

For practice, better understanding and mastery of voltage drop calculations, the following exercises are suggested.

Another method of finding the voltage drop is:
Use steps 1 through 3 above, then:

9. In Index, find "Conductors," under which find "Copper, Properties, Chap. 9, Table 8."

10. In Table 8, we find the resistance of a 10 AWG uncoated stranded copper conductor to be 1.24 ohms per 1000 ft. The length of conductor to the load and back (2 x 350 feet) = 700 ft.

11. 700 ft./1000 ft = 0.7
0.7 x 1.24 = 0.868

12. Use the Ohm's Law Formula
VD (Volts Drop)
E = I x R.
E = 12 amps x 0.868 ohms
E = 10.416 voltage drop

Note: This is greater than the allowed 6.9 volts (3 percent of 230 volts).

13. Per Table 8, the resistance of an 8 AWG copper uncoated stranded copper conductor is 0.778 ohms per 1000 ft.

700 ft / 1000 ft = 0.7
0.7 x 0.778 = 0.5446 ohms

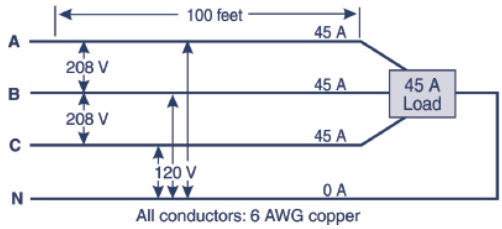
14. Again, use the Ohm's Law Formula
VD (Volts Drop)
E = I x R.
E = 12 amps x 0.5446 ohms
E = 6.5352 volts

Note: This is within the permitted 3 percent (6.9 volts drop) permitted in the question.

15. The correct answer is C.

2 A 208Y/120-volt, 3-phase, 4-wire wye-connected circuit to a process machine is 100 feet to the machine from the circuit breaker and has 45 amperes per phase of balanced resistance load. What is approximate percentage of voltage drop?

Note: Assume an ambient temperature of 75°C (167°F) and a conductor K (constant) factor of 12.9.



A. 1.5 percent
B. 1.8 percent
C. 2.6 percent
D. 3.0 percent

ANSWER _____

PROCEDURE TO ESTABLISH ANSWER
The question is about calculating voltage drop.

K = 12.9
L = Length of circuit in feet (one way)
VD = Volt Drop
I = Current
Cm = Circular mil area of 6 AWG (Chapter 9, Table 8) = 26,240 cm

(6 AWG would be the required conductor size for the 45-ampere load.)

By using voltage drop formulas, use either of the following methods:

Note: it is very important to know how and where we get the formulas used, and how to use them. In the past, some engineers have used 2 and .866 in formulas for 3-phase voltage drop formulas. Many have wondered, *Where did the .866 come from?* The answer is: 2 x .866 = 1.732. You can choose to use 2 x .866 or just use 1.732 for 3-phase voltage drop calculations. For these calculations, we will use 1.732.

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STUDY GUIDE

ELECTRICAL INSPECTOR CERTIFICATION PROGRAM

First line of electrical safety is the Plan Review.

Can you determine whether plans comply with the 2017 National Electrical Code? This knowledge is essential for doing the work and for passing the certification exam.

Plan Review Study Guide helps you improve your certification exam score by doing four things:

- Become familiar with the use of the *NEC*
- Know exactly what the Code covers and where it can be found
- Focus in on key words and consider carefully what is being asked
- Practice answering the question first, before checking the multiple *NEC* choices available

That's the design of this study guide: locate information quickly and accurately. If you patiently and carefully walk through these questions and pay attention to what the question is asking, you will be considerably more knowledgeable about the Code arrangement and how to find references when you reach the last page.

Plan Review Study Guide is particularly useful for busy people who are working and studying at the same time. It not only gives you correct answers, but it also teaches you the steps to solve the problems and to navigate the *National Electrical Code* to find the answers quickly and efficiently.

Take the first step in the certification process in becoming an electrical plans reviewer.

International Association of Electrical Inspectors
901 Waterfall Way, Suite 602
Richardson, TX 75080-7702

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