ELECTRICAL GENERAL NEC 2017

STUDY GUIDE

ELECTRICAL INSPECTOR CERTIFICATION PROGRAM

Commerical Industrial Residential

ELECTRICAL GENERAL 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."

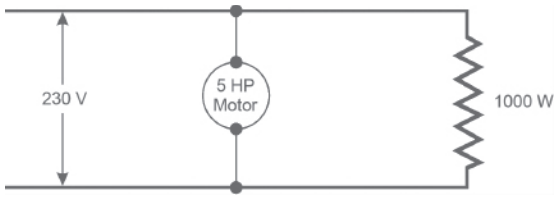
This study guide is divided into subject categories, and each category has several questions. Each question is followed by the procedure for finding the correct answer. Follow the procedures step by step to learn good work habits. The answers are listed in the back of the book. Do not look up the answers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

Motors

1 What is the minimum size of Type THW copper conductors required to supply a load consisting of a 5-horsepower motor and a 1000-watt resistive appliance on one branch circuit? The circuit operates at 240 volts, single-phase.



A. 10 AWG
B. 8 AWG
C. 6 AWG
D. 1 AWG

ANSWER _____

PROCEDURE TO ESTABLISH ANSWER

The question is about sizing conductors for motor and an appliance on one branch circuit. Establish the key words in the question: motor, branch circuit, and minimum size of conductors.

1. In Index, find "Motors" under which find "Branch circuits" under which find "Combination loads, 430.54, 430.63." Scanning these sections quickly, we find they will not apply as 430.54 is regarding the rating of the ground-fault and short-circuit protective device and 430.63 is regarding feeders.

2. In the Index under "Motors," find "Conductors" and a reference to "Combination Loads, 430.25." Checking 430.25 we find a reference to 430.24 where the equipment is not factory wired. If we continue to scan under "Motors," "Conductors" find "Motor and other Loads, 430.24."

3. Section 430.24 requires that conductors supplying several motors, or a motor(s) and other load(s), shall have an ampacity not less than the sum of each of the following:

   (1) 125 percent of the full-load current rating of the highest rated motor, as determined by 430.6(A).

(2) Sum of the full-load current ratings of all the other motors in the group, as determined by 430.6(A)

(3) 100 percent of the noncontinuous non-motor load

(4) 125 percent of the continuous non-motor load.

4. Section 430.24 refers to 430.6(A) to determine the full-load currents of the motors. Section 430.6(A) requires the ampere rating of a motor to be taken from Article 430 tables where sizing of conductors is concerned. Table 430.248 rates a 5-horsepower single-phase, 230-volt motor full-load current at 28 amperes.

5. Where the type of resistive load is not otherwise specified, Section 220.14(A) requires the rating to be that of the appliance or load served, which is 1000 VA ÷ 240 V = 4.2 amperes.

6. (28 A x 125% = 35 A) + 4.2 = 39.2 amperes total load.

7. Table 310.15(B)(16) requires a minimum of 8 AWG Type THW copper conductor.

8. The correct answer is B.

2 Which one of the following statements about motor control circuits is NOT true?

A. If one side of a motor control circuit is grounded, the control circuit must be arranged so that an accidental ground in the remote control devices will not start the motor.
B. Motor control circuit conductors are always considered as protected by the motor branch-circuit short-circuit and ground-fault protective device.
C. If one side of a motor control circuit is grounded, the control circuit must be arranged so that an accidental ground in the remote control devices will not bypass automatic safety shutdown devices.
D. Where damage to a motor control circuit would constitute a hazard, all conductors of such circuits outside the control device shall be installed in a raceway or otherwise protected from physical damage.

ANSWER _____

PROCEDURE TO ESTABLISH ANSWER

The question is about motor control circuits.

1. In Index, find "Motors" under which find "Control circuits, 430–Part VI."

2. Scan Part VI and find Section 430.73, Protection of Conductors from Physical Damage and find that Answer D is true.

3. Section 430.74, Electrical Arrangement of Control Circuits, requires that where one conductor of the motor control circuit is grounded, the motor control circuit shall be arranged so that a ground fault in the control circuit remote from the motor controller will (1) not start the motor and (2) not bypass manually operated shutdown devices, or automatic safety shutdown devices. Answers A and C are true.

4. Overcurrent protection for motor control circuits is covered by Section 430.72, and in cases where the control circuit conductors leave the motor control equipment enclosure the branch-circuit overcurrent protective device may be too large to protect the control circuit conductors. (See Table 430.72) Answer B is not true.

5. The correct answer is B.

3 The disconnecting means for a torque motor shall have an ampere rating of at least what percentage of the motor nameplate current?

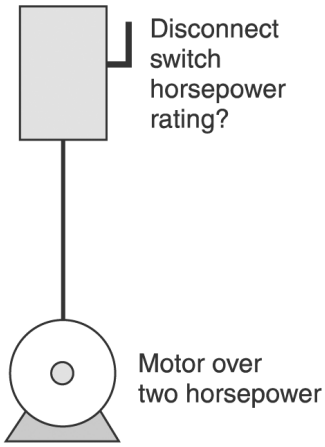
A. 115 percent
B. 125 percent
C. 140 percent
D. 150 percent

ANSWER _____

PROCEDURE TO ESTABLISH ANSWER
The question is about motor disconnecting means.

1. In Contents, under "Chapter 4, Equipment for General Use" find "Article 430, Motors, Motor Circuits, and Controllers" under which find "Part IX. Disconnecting Means." You can also find "Motors" in the Index and find "Disconnecting Means, 430.95, 430-IX."
2. Scan Article 430–Part IX and find 430.110, Ampere Rating and Interrupting Capacity.
3. Section 430.110(B) requires the disconnecting means for a torque motor to have an ampere rating of at least 115 percent of the motor nameplate current.
4. The correct answer is A.

4 If the disconnecting means for a 230-volt ac, 5-horsepower motor is a listed motor-rated switch, the switch must be not less than which horsepower rating.



A. 5 horsepower
B. 7 horsepower
C. 10 horsepower
D. 15 horsepower

ANSWER _____

PROCEDURE TO ESTABLISH ANSWER
The question is about disconnecting means for motors, specifically a switch.

1. In Contents, under "Chapter 4 Equipment for General Use" find "Article 430, Motors, Motor Circuits, and Controllers" under which find "Part IX. Disconnecting Means." You could also use the Index, and find "Motors" under which find "Disconnecting means, 430–Part IX."

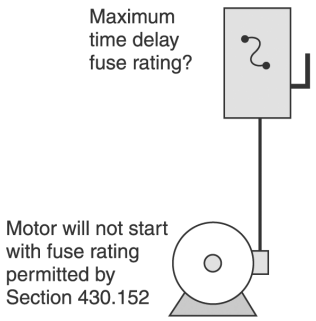
2. Scan Article 430, Part IX and find Section 430.109, Type.

3. Section 430.109(A)(1) generally requires a horsepower rated switch unless another type of disconnect is otherwise permitted in (B) through (G), under the conditions specified.

4. 5 hp is the rated motor horsepower stated in the question.

5. The correct answer is A.

5 Where motor branch-circuit short-circuit and ground-fault protection is provided by time-delay (dual-element) fuses and their rating specified in Exception 1 is not sufficient to start the motor, it shall be permitted to increase their rating to what percentage of the full-load current rating of the motor, (while not exceeding standard ampere ratings of overcurrent devices)?



A. 150 percent
B. 175 percent
C. 225 percent
D. 400 percent

ANSWER _____

PROCEDURE TO ESTABLISH ANSWER

The question is about the rating of the motor branch-circuit short-circuit and ground-fault protection.

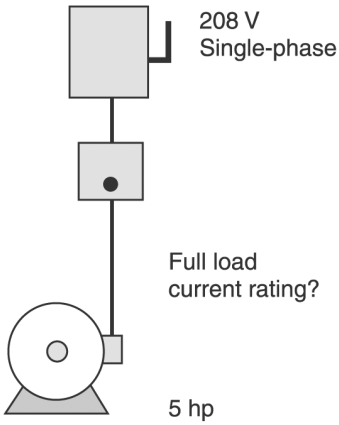
1. In Index, find "Motors" under which find "Rating or setting of branch-circuit short-circuit and ground-fault devices Table 430.52."

2. Section 430.52, Rating or Setting for Individual Motor Circuit.

3. Section 430.52(C)(1) states the protective device rating cannot exceed the values permitted in Table 430.52. Exception No. 2(b) to Table 430.52 allows a time-delay fuse to be increased to no more than 225 percent of the full-load current of a motor where the rating specified in Table 430.52 or the rating modified by Exception No. 1 is not sufficient to start the motor.

4. The correct answer is C.

6 The full-load current rating of a 5-horsepower, single-phase, 208-volt motor is:



A. 15.2 amperes
B. 16.7 amperes
C. 28.0 amperes
D. 30.8 amperes

ANSWER _____

PROCEDURE TO ESTABLISH ANSWER
The question is about full-load current ratings of motors.

1. In Index, find "Motors" under which find "Current, full load. *see* Full-load current motors." In Index, find "Full-load current motors," under which find "Alternating current, Single-phase, Table 430.248."

2. Table 430.248 specifies a full-load current of 30.8 amperes for the specified motor.

3. The correct answer is D.

Note: Section 430.6(A)(1) requires that this value be used to size the components of the motor circuit, except the motor overload protection, which must be based on the actual motor nameplate ampere rating. Overload protection is found in Part III of Article 430. The full load current value in amperes from the table will normally be higher than the ampere rating on the nameplate.

7 Two or more motors, rated at one horsepower or less, may be connected to a single 20-ampere, 120-volt branch circuit if all of the following conditions are met EXCEPT:

A. The motor is protected by time-delay fuses.
B. The full-load rating of each motor does not exceed 6 amps.
C. The rating of the branch-circuit short-circuit and ground-fault protective device marked on any of the controllers is not exceeded.
D. Individual overload protection is provided per 430.32.

ANSWER _____

PROCEDURE TO ESTABLISH ANSWER
The question is about branch-circuit protection for more than one motor on a single circuit.

1. In Index, find "Motors" under which find "Grouped, 430.24, 430.42, 430.53, 430.87 and 430.112 Ex."

2. Section 430.53(A) is applicable since the question relates to several motors not over 1 horsepower connected to one branch circuit.

3. Section 430.53(A) permits an installation where several motors are connected to a 120-volt, 20-ampere circuit provided all the conditions are met. Answers B, C, and D are correct.

4. There is no requirement for the type of protection included in the conditions so Answer A is not true.

5. The correct answer is A.

8 What minimum size copper THW branch-circuit conductors are required to serve a 20-horsepower elevator motor with a nameplate rating of 34 amperes. The motor is 3-phase 460-volt and is 5-minute rated due to the intermittent duty.

A. 14 AWG copper
B. 12 AWG copper
C. 10 AWG copper
D. 8 AWG copper

ANSWER _____

PROCEDURE TO ESTABLISH ANSWER

The question is about finding the size of branch-circuit conductors for an elevator motor.

1. In Index, find "Motors" under which find "Conductors, 430–Part II" under which find "Intermittent Duty, 430.22(E)," which will refer you to Table 430.22(E).

2. In the Table, find "Classification of Service." Under "Classification of Service," find "Intermittent duty freight and passenger elevators…" (the second item)

3. Under "Nameplate Current Rating Percentages," find "5-Minute Rated Motor" (the first column).

4. You will find that the conductors must be rated not less than 85% of the full load current rating of the motor, rather than the standard 125% for a continuous duty motor. Remember that the elevator motor in this case does not operate continuously, and therefore does not generate as much heat into the conductors and other parts of the motor circuit that a continuous duty motor would.

5. Under "Full-load current motors" in the Index, find "Alternating Current," under which find "Three-phase, Table 430.250."

6. Table 430-250 indicates that a 460-volt, 3-phase motor draws 27 amperes; however, the question indicates the high-torque elevator motor nameplate current rating is 34 amperes. Section 430.6(A)(1) generally requires that Tables 430.247 through 430.250 be used to size the components of the motor circuit, except that for high-torque motors, where the actual motor nameplate ampere rating must be used.

7. Section 430.22(E) addresses conductor sizing for motors that are other than continuous duty. In this case, the motor is an intermittent duty [see note at the bottom of Table 430.22(E)]. The question indicates the nameplate current rating of the elevator motor is 34 amperes.

8. 34 amperes x 85% = 28.9

9. In accordance with 310.15 and Table 310.15(B)(16) a 10 AWG conductor would be required. The correct answer is C.

9 A central heating and air-conditioning unit has the following information on the nameplate: "Minimum Circuit Ampacity — 28 Amps; Maximum Fuse Size- 45 Amps." What is the minimum size Type THW conductor that may be used to supply this unit?

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

ANSWER _____

PROCEDURE TO ESTABLISH ANSWER
This question is about sizing the branch-circuit conductors for heating and air-conditioning equipment.

1. In Index, under "Air-conditioning and refrigerating equipment" find "Branch circuit," under which find "Conductors, 440–Part IV," under which find "Ampacity, determination of, 440.6."

2. Section 440.6 provides the conductors be sized in accordance with Table 310.16(B)(15) with their ampacity being determined in by 440.6(A) or (B). Section 440.6(A) requires the nameplate value to be used for sizing the branch-circuit conductors for a hermitic refrigerant motor compressor.

3. The "minimum circuit ampacity" marked on the label, 28 amperes in our case, is used to determine the conductor size so scanning Table 310.15(B)(16) we find a 10 AWG copper conductor is adequate to supply the load.

4. The correct answer is B.

Note: Section 440.33 specifies the procedure that must be used to determine the minimum circuit ampacity. This generally requires the conductors to have an ampacity that is not less than the sum of: the rated-load or branch circuit selection current of all compressors plus the full-load rating of all other motors plus 25 percent of the highest motor-compressor or motor full-load current in the group. Section 440.4(B) requires this information to be marked on the label. Additionally, note that 440.35 requires the minimum circuit ampacity to be used for selecting the branch-circuit conductors to multimotor and combination-load equipment. The maximum fuse size is a separate item and it is typically used for selecting the short-circuit and ground-fault protection, rating of disconnects, etc.

10 Branch-circuit conductors supplying a single motor in a continuous duty application shall have a current-carrying capacity of not less than what percentage of full-load current of motor?

A. 115 percent
B. 125 percent
C. 175 percent
D. 250 percent

ANSWER _____

PROCEDURE TO ESTABLISH ANSWER
The question is about sizing of branch-circuit conductors for a continuous duty motor.

1. In Index, find "Motors" under which find "Branch circuits, 430–Part II" under which find "Conductors, 430–II," under which find "Continuous duty, 430.22."

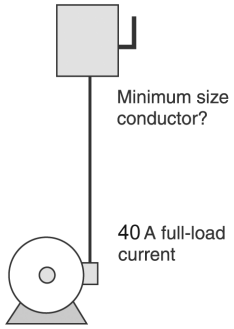
2. The index identified Part II of Article 430 for motor circuit conductors in two places. It can also be found in the Table of Contents under Article 430 which will provide the page number where Part II

starts. Section 430.22, regarding single motors, is generally located on the same page with the title for Part II so it is easily found.

3. Section 430.22 requires branch-circuit conductors supplying a single motor to have an ampacity not less than 125 percent of the motor's full-load current rating.

4. The correct answer is B.

11 Which one of the following is the minimum permitted size of Type THW copper branch-circuit conductors supplying a continuous duty motor with a full-load current value of 40 amperes determined from Tables 430.247–250? Assume all terminations are rated 75°C.



A. 14 AWG
B. 12 AWG
C. 10 AWG
D. 8 AWG

ANSWER _____

PROCEDURE TO ESTABLISH ANSWER
The question is about sizing motor branch-circuit conductors.

1. In Index, find "Motors" under which find "Branch circuits, 430–Part II." Scan "Part II, Motor Circuit Conductors," under which find "430.22, Single Motor."

2. Section 430.22 requires branch-circuit conductors supplying a single motor in a continuous duty application to have an ampacity not less than 125 percent of the motor full-load current rating as determined by 430.6(A)(1).

3. 125% x 40 A = 50 amps, which is the minimum ampacity of motor branch-circuit conductors.

4. Referring to ampacity Table 310.15(B)(16), 8 AWG Type THW copper is rated 50 amperes, with 75°C terminals, while the next smaller size, 10 AWG, is only rated at 35 amperes.

5. The correct answer is D.