

ELECTRICIAN'S EXAM PREPARATION GUIDE

Tenth Edition

Based on the 2017 *NEC*®

by

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Revised and Updated by

Rob Adair

Includes inside the back cover:



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National Fire Protection Association® (NFPA®)

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John D. Lee, Sr., Question Verification & Code Consultant

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Introduction — How to Use This Book

If you have been installing electrical systems for some time as an apprentice, helper, or unlicensed electrician, this book is for you. The information between the covers of this book will cover every subject that is likely to appear on most electrician's exams — either state or local.

If you are just starting your career as an apprentice electrician, this book is also for you. It begins at the beginning. You will have no trouble understanding what is explained here. Read each page carefully and you will soon earn the recognition that licensed professionals are entitled to in our present society. The financial rewards are another factor which will make your efforts worthwhile.

In most communities, any electrician working *without supervision* must be licensed. For larger electrical construction projects, many states now require the certification of journeyman electricians as well as specialty electricians, such as splicers of high-voltage cable. This trend is certain to continue as legislatures recognize the need to protect the public from incompetents. The state of Virginia, for example, is now requiring all persons doing electrical work to be licensed.

Most licensing authorities prepare demanding exams that are a good test of the examinee's knowledge. These exams help to guarantee that electrical systems installed in building construction will meet minimum standards for protecting the lives and health of building occupants (and the buildings themselves) for many years to come. This also helps to keep insurance rates to a minimum.

Begin your study for any electrician's exam with two points in mind:

- Take the exam seriously
- Every minute spent studying this book increases your chances of passing the exam

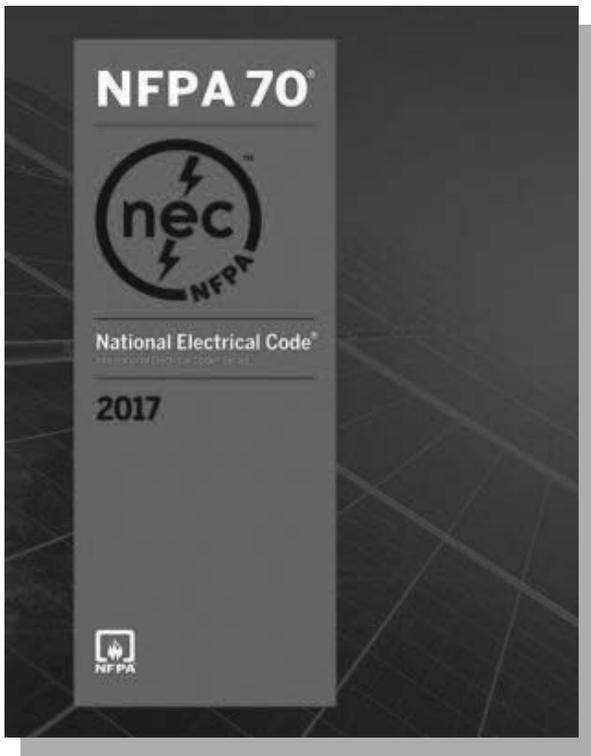
You can pass any electrician's exam, but only if you study carefully each of the questions in this book. What you learn from studying is the foundation on which your professional career will be built.

Understand also that the licensing authority isn't the enemy. They aren't trying to keep you out of the electrical business. They only want to set some basic standards and be assured that your installations will be done in a workmanlike manner and in accordance with the latest edition of the *National Electrical[®] Code[®] (NEC[®])*. The public should be assured that all licensed electricians are knowledgeable professionals. That's good for society in general, and it's good for all professional electricians and electrical contractors who live and work in your area.

Unfortunately, there are too many applicants who are not well prepared when they sit down to take the electrician's exam. Taking an electrician's exam without doing a good job of preparation is a complete waste of time — both yours and that of the licensing authority. The results are predictable. Don't make that mistake.

The most common reason for failure is that the applicant didn't study properly because he didn't know how, or studied the wrong material. This book should put an end to that excuse. You have in your hands the most complete, easiest-to-use, most practical reference available for preparing to take the tests that are actually given today. Read this book carefully, examine every question, understand all the answers. Do this, and there's no way you will be unprepared on examination day. You are almost certain to score high.

All the common questions and answers are here, but just knowing the answer is not always enough. Sometimes it is just as important to understand why a particular answer is correct. That's why many answers include a quotation or reference



The **National Electrical Code (NEC)** has become the Bible of the electrical industry

section from the *National Electrical Code*. Sometimes you will find notes or clarifications under the answer when there is an important point you might miss.

The *National Electrical Code* is used in practically every area of the United States for inspecting electrical systems in building construction. Most of the questions appearing on electrician's exams will come directly from Articles and Sections of the latest *NEC*. Therefore a brief review of the individual *NEC* sections that apply to electrical systems is in order. Sample questions concerning all sections of the *NEC* may be found in the chapters to follow.

This book, however, is not a substitute for the *NEC*. You need a copy of the most recent edition and it should be kept handy at all times. The more you know about the code, the more you are likely to refer to it.

NEC Terminology

There are two basic types of rules in the *NEC*: mandatory rules and advisory rules. Here is how to recognize the two types of rules and how they relate to all types of electrical systems.

Mandatory rules: All mandatory rules have the terms *shall* or *shall not* in them. The terms mean must. If a rule is mandatory, you must comply with it.

Permissive rules: All advisory rules have the terms *shall be permitted* or *shall not be required* in them. The terms in this case mean *recommended but not necessarily required*. If a rule is advisory, compliance is discretionary. If you want to comply with it, do so. But you don't have to if you don't want to.

Be alert to local amendments to the *NEC*. Local ordinances may amend the language of the *NEC*, changing it from *should* to *shall*. This means that you must do in that county or city what may only be recommended in some other area. The office that issues building permits will either sell you a copy of the code that's enforced in that county or tell you where the code is sold.

Learning the Layout of the NEC

Begin your study of the *NEC* with Articles 100 and 110. These two articles have the basic information that will make the rest of the *NEC* easier to understand. Article 100 defines terms you will need to understand when you apply the code. Previous editions of the *NEC* had some definitions located in the body of the code where the topic was covered, but starting with the 2014 *NEC*, most of these were brought together into Article 100 - Definitions. Article 110 gives the general requirements for electrical installations. Read these two articles over several times until you are thoroughly familiar with all the information they contain. It's time well spent.

Once you're familiar with Articles 100 and 110, you can move on to the rest of the code. There are several key sections you will use often in servicing electrical systems. Let's discuss each of these important sections.

Wiring and Protection

Chapter 2 of the *NEC* discusses wiring design and protection, the information electrical technicians need most often. It covers the use and identification of grounded conductors, branch circuits, feeders, calculations, services, overcurrent protection, grounding, bonding and surge protection. This is essential information for any type of electrical system, regardless of the type.

Chapter 2 is also a “how-to” chapter. It explains how to provide proper spacing for conductor supports and how to size the proper grounding conductor or electrode. If you run into a problem related to the design or installation of a conventional electrical system, you can probably find a solution for it in this chapter.

Wiring Methods and Materials

Chapter 3 has the rules on wiring methods and materials. The materials and procedures to use on a particular system depend on the type of building construction, the type of occupancy, the location of the wiring in the building, the type of atmosphere in the building or in the area surrounding the building, mechanical factors and the relative costs of different wiring methods.

The provisions of this chapter apply to all wiring installations except remote control switching (Article 725), low-energy power circuits (Article 725), signal systems (Article 725), communication systems and conductors (Article 800) when these items form an integral part of equipment such as motors and motor controllers.

There are three basic wiring methods used in most modern electrical systems. Nearly all wiring methods are a variation of one of these three basic methods:

- Sheathed cables of two or more conductors, such as NM cable and AC armored cable (Articles 320 through 340)
- Raceway wiring systems, such as rigid and EMT conduit (Articles 342 through 366)
- Busways (Article 368)

Article 310 in Chapter 3 gives a complete description of all types of electrical conductors. Electrical conductors come in a wide range of sizes and forms. Be sure to check the working drawings and specifications to see what sizes and types of conductors are required for a specific job. If conductor type and size are not specified, choose the most appropriate type and size meeting standard *NEC* requirements.

Articles 312 through 399 include rules for raceways, boxes, cabinets, low-voltage distribution, concealed knob-&-tube wiring, open wiring, and outdoor overhead conductors. Outlet boxes vary in size and shape, depending on their use, the size of the raceway, the number of conductors entering the box, the type of building construction, and the atmospheric condition of the areas. Chapter 3 should answer most questions on the selection and use of these items.

The *NEC* does not describe in detail all types and sizes of outlet boxes. But manufacturers of outlet boxes have excellent catalogs showing all of their products. Collect these catalogs. They're essential to your work.

Equipment for General Use

Chapter 4 of the *NEC* begins with the use and installation of flexible cords and cables, including the trade name, type, letter, wire size, number of conductors, conductor insulation, outer covering and use of each. The chapter also includes fixture wires, again giving the trade name, type, letter and other important details.

Article 404 covers the switches you will use to control electrical circuits.

Article 406 covers receptacles and convenience outlets used to connect portable equipment to electric circuits. Get the manufacturers' catalogs on these items. They will provide you with detailed descriptions of each of the wiring devices.

Article 408 covers switchboards, switchgear and panelboards, including their location, installation methods, clearances, grounding and overcurrent protection.

Article 409 covers industrial control panels.

Article 410 on lighting fixtures is especially important. It gives installation procedures for fixtures in specific locations. For example, it covers fixtures near combustible material and fixtures in closets. The *NEC* does not describe the number of fixtures needed in a given area to provide a certain amount of illumination.

Low-voltage lighting is in Article 411.

Article 422 covers appliances; 424 fixed electrical space heating equipment; 425 fixed resistance heating equipment; 426 fixed outdoor deicing equipment and 427 fixed heating equipment for pipelines and vessels.

Article 430 covers electric motors, including mounting the motor and making electrical connections to it.

Articles 440 through 470 cover air conditioning and heating equipment, generators, transformers, and capacitors.

Article 480 gives most requirements related to battery-operated electrical systems. Storage batteries are seldom thought of as part of a conventional electrical system, but they often provide standby emergency lighting service. They may also supply power to security systems that are separate from the main AC electrical system.

Article 490 covers equipment over 1000 volts, nominal.

Special Occupancies

Chapter 5 of the *NEC* covers special occupancy areas. These are areas where the sparks generated by electrical equipment may cause an explosion or fire. The hazard may be due to the atmosphere of the area or just the presence of a volatile material in the area. Commercial garages, aircraft hangers and service stations are typical special occupancy locations.

Articles 500 through 503 cover the different types of special occupancy atmospheres where an explosion is possible. The atmospheric groups were established to make it easy to test and approve equipment for various types of uses.

Section 501 covers the installation of explosionproof wiring. An explosion-proof system is designed to prevent the ignition of a surrounding

explosive atmosphere when arcing occurs within the electrical system.

There are three classes of special occupancy locations:

- Class I (Article 501): Areas containing flammable gases or vapors in the air. Class I areas include paint spray booths, dyeing plants where hazardous liquids are used, and gas generator rooms.
- Class II (Article 502): Areas where combustible dust is present, such as grain-handling and storage plants, dust and stock collector areas and sugar-pulverizing plants. These are areas where, under normal operating conditions, there may be enough combustible dust in the air to produce explosive or ignitable mixtures.
- Class III (Article 503): Areas that are hazardous because of the presence of easily ignitable fibers or flyings in the air, although not in large enough quantity to produce ignitable mixtures. Class III locations include cotton mills, rayon mills and clothing manufacturing plants.

Articles 504 and 506 cover intrinsically safe systems and locations for combustible dusts or ignitable fibers.

Articles 511, 513 and 514 regulate garages, aircraft hangars and similar locations where volatile or flammable liquids are used. While these areas are not always considered critically hazardous locations, there may be enough danger to require special precautions in the electrical installation. In these areas, the *NEC* requires that volatile gases be confined to an area not more than 18 inches above the floor. So in most cases, conventional raceway systems are permitted above this level. If the area is judged critically hazardous, *explosion-proof* wiring (including seal-offs) may be required.

Article 520 regulates theaters and similar occupancies where fire and panic can cause hazards to life and property. Drive-in theaters do not present the same hazards as enclosed auditoriums. But the projection rooms and adjacent areas must be properly ventilated and wired for the protection of operating personnel and others using the area.

Chapter 5 also covers service stations, bulk storage plants, health care facilities, residential storage garages, agricultural buildings, carnivals and circuses, motion picture and television studios, and manufactured buildings, mobile homes, amusement parks, low-voltage systems, marinas and boatyards and temporary installations.

Special Equipment

Article 600 covers electric signs and outline lighting. Article 604 covers manufactured wiring systems. Article 605 covers office furnishings. Article 610 applies to cranes and hoists. Article 620 covers the majority of the electrical work involved in the installation and operation of elevators, dumbwaiters, escalators and moving walks. The manufacturer is responsible for most of this work. The electrician usually just furnishes a feeder terminating in a means of disconnect in the bottom of the elevator shaft. The electrician may also be responsible for a lighting circuit to a junction box midway in the elevator shaft for connecting the elevator cage lighting cable and exhaust fans. Articles in Chapter 6 of the *NEC* give most of the requirements for these installations.

Article 625 covers electric battery charging system requirements for plug-in hybrid electric vehicles (PHEV). Article 626 regulates installation of parking spaces for electrified trucks. Connecting to Truck Stop Electrification (TSE) equipment will allow truck operators to use on-board air conditioning, heating and appliances without running their engines.

Article 630 regulates electric welding equipment. It is normally treated as a piece of industrial power equipment requiring a special power outlet. But there are special conditions that apply to the circuits supplying welding equipment. These are outlined in detail in Chapter 6 of the *NEC*.

Article 640 covers wiring for sound-recording and similar equipment. This type of equipment normally requires low-voltage wiring. Special outlet boxes or cabinets are usually provided with the equipment. But some items may be mounted in or on standard outlet boxes. Some sound-recording electrical systems require direct current, supplies from rectifying equipment, batteries or motor generators. Low-voltage alternating current comes from relatively small transformers connected on the primary side to a 120-volt circuit within the building.

Other items covered in Chapter 6 of the *NEC* include: information technology equipment (Article 645), modular data centers (Article 646), sensitive electronic equipment (Article 647), pipe organs (Article 650), X-ray equipment (Article 660), induction and dielectric heat-generating equipment (Article 665), electrolytic cells (Article 668), electroplating (Article 669), industrial machines (Article 670), and irrigation machines (Article 675). Articles 680 and 682 regulate installations of swimming pools, fountains, spas, and natural or artificially-made bodies of water. Articles 685 through 692 cover items like integrated electric systems, solar photovoltaic (PV) systems, and fuel cells. Article 694 covers the increasingly popular small wind electric systems. This article governs the wiring requirements as well as connection to other sources. It's advisable to pay particular attention to these newer code articles, as most states like to include numerous questions on newer code changes. Chapter 6 ends with Article 695, covering Fire Pumps.

If you ever have work that involves Chapter 6, study the chapter before work begins. That can save a lot of installation time. Here's another way to cut down on labor hours and prevent installation errors. Get a set of rough-in drawings of the equipment being installed. It's easy to install the wrong outlet box or to install the right box in the wrong place. Having a set of rough-in drawings can prevent those simple but costly errors.

Special Conditions

In most commercial buildings, the *NEC* and local ordinances require a means of lighting public rooms, halls, stairways and entrances. There must be enough light to allow the occupants to exit from the building if the general building lighting is interrupted. Exit doors must be clearly indicated by illuminated exit signs.

Chapter 7 of the *NEC* covers the installation of emergency lighting systems. These circuits should be arranged so that they can automatically transfer to an alternate source of current, usually storage batteries or gasoline-drive generators. As an alternative, you can connect them to the supply side of the main service so disconnecting the main service switch would not disconnect the emergency circuits. The 2017 *NEC* showed significant changes in the requirements in Article 770, optical fiber cables.

Electrician's Exam Preparation Guide

Chapter 8 covers communication systems and is not subject to the requirements of Chapters 1 through 7, except where specifically referenced. In addition to communications circuits, Chapter 8 covers: radio and television equipment, antennas and distribution systems, network-powered broadband systems, and the newly-added Article 840 (premises-powered broadband communication systems).

How to Prepare for the Exam

This book is a guide to preparing for the journeyman or master electrician's exam. It isn't a substitute for studying the recommended references and it won't teach you the electrical trade. But it will give you a *complete knowledge of the type of questions* asked in the electrician's exam. It will also give you a "feel" for the examination and provide some of the confidence you need to pass.

Emphasis is on multiple-choice questions because that's the style that nearly all tests utilize. Questions are grouped into chapters. Each chapter covers a single subject. This will help you discover your strengths and weaknesses. Then when you take the two "final" sample exams in the back of this book, analyze the questions you miss. You'll probably notice you are weaker in some subjects than others. When these areas have been discovered, you will know that further study is necessary in these areas.

In answering questions on the NEC, remember this point: All exam questions are based on minimum NEC requirements. If the minimum wire size permitted under the NEC to carry 20 amperes is No. 12 AWG and you answer No. 10 AWG (minimum size for 30 amperes) just to play it safe, your answer is incorrect.

The preparatory questions in the front part of this book have the answer after each question. When reading a question, cover the answer. Read the question carefully. Mark your answer on a separate sheet of paper before looking at the correct answer. Check to see if your answer is correct. If it isn't, read the code responses to find out why it is wrong.

How to Study

Set aside a definite time to study, following a schedule that meets your needs. Studying a couple of hours two or three nights each week is better than studying all day on, say, Saturdays. The average

mind can only concentrate for approximately four hours without taking a break. There's no point in studying if you don't retain much of the information. Study alone most of the time, but spend a few hours reviewing with another electrician buddy before exam day. You can help each other dig out the facts and concepts you will need to pass the exam.

Try to study in a quiet, well-lighted room that is respected as your study space by family members and friends. If it's hard to find a spot like that in your home, go to the local library where others are reading and studying.

Before you begin to study, spend a few minutes getting into the right frame of mind. That's important. You don't have to be a genius to pass the electrician's exam. But good motivation will nearly guarantee your success. No one can provide that motivation but you. Getting your license is a goal you set for yourself; it's your key to the future — a satisfying career in the electrical industry.

As you study the NEC and other references, highlight important points with a marker. This makes it easier to find important passages when you're doing the final review — and when you're taking the exam.

Put paper tabs on the corners of each major section in all the references you will take into the exam room. On the portion of the tab that extends beyond the edge of the book, write the name of the section or the subject. That makes locating each section easier and quicker — an important consideration on an open book test. Speed in locating answers is important. In the sample exams at the end of this book, which are based on actual state and county examinations, you will have from two to four minutes to answer each question, so you don't have time to daydream or mess around. If you want to pass the exam, you must take it seriously.

Your study plan should allow enough time to review each reference at least three times. Read carefully the first time. The next review should take only about 10% of the time that the first reading took. Make a final review of all references and notes on the day before the exam. *This is the key to success in passing the exam: Review, review, review!* The more you review, the better your grasp of the information and the faster you will be able to find the answers.

The Examination

Questions on state and local examinations are usually compiled by members of the electrician's examination board. Board members usually include several electrical contractors, a registered electrical engineer, electrical inspectors, and perhaps a trade school instructor. Most electrician's exams will include questions on the *NEC*, general knowledge of electrical practice, theoretical questions, and local ordinance rules. All of these fields are covered in this preparation guide. Questions about the *NEC*, including rules and design calculations, comprise from 70% to 80% of the examination.

State examinations are usually given twice a year, or perhaps every three months. County and local exams may be taken almost any time with prior notice to the local inspectors. Most have several basic exams that are used in rotation. But the same examination will never be administered twice in a row.

The people compiling the exams maintain a bank of several hundred questions covering each test subject. Questions are selected at random, and chances are that some of the questions on any exam have already been used on an earlier examination. Many of the questions appearing on actual electrician's exams will closely resemble questions appearing in this book.

The format of the actual examination, the time allowed, and the reference material which the applicant may be allowed to take into the examination room vary with each locality. Typically, an applicant is allowed six to eight hours to complete the examination. Applicants are usually required to report to the examination room at 8 a.m. where the proctors take about 15 minutes to explain the rules of taking the exam. The applicants then work on the "morning" exam until noon. After an hour break for lunch, the "afternoon" exam begins at 1 p.m. and applicants are given until about 4 p.m. to complete this portion.

The Answer Sheet

Most answer sheets used today are designed for computer grading. Each question on the exam is numbered. Usually there will be four or five possible responses for each question. You will be required to mark the best answer on the answer sheet. The following is a sample of a multiple-choice question:

1) While most electrical outlets in homes in the U.S. are 110 volts, which of the following appliances usually requires a 220-volt outlet?

- (A) Toaster oven
- (B) Washing machine
- (C) Clothes dryer
- (D) Space heater

You should mark answer C for question 1 on the answer sheet.

Answer sheets will vary slightly for each examining agency so be sure to follow any instructions on that sheet. Putting the right answers on the wrong section will almost certainly cause you to fail.

The Night Before

Give your mind a rest! If you have not prepared correctly for the exam by this time, then you can't cram it all into your brain in one night. So take it easy. If the place of the examination is more than an hour's drive from your home, you might want to stay at a motel in the city where the examination is being held. Getting up at, say, 4 a.m. and driving a couple of hours in heavy traffic will not help you to pass the exam. On the other hand, a drive to the location the afternoon before the exam, a good dinner and a relaxing evening watching TV will increase your possibilities of passing. Just don't stay up too late.

Be sure to have all of your reference material with you and get a good night's sleep before the day of the exam. If you have prepared yourself correctly, you should pass with flying colors.

Examination Day

On the day of your examination, listen carefully to any oral instructions given and read the printed directions. Failing to follow instructions will probably disqualify you.

You will seldom find any trick questions, but many will require careful reading. Certain words (like *shall*, *should*, *always* and *never*) can make a big difference in your answer.

Sometimes several of the answers may seem possible, but only one will be correct. If you are not sure of the answer, use the process of elimination.

There are several ways to take an exam, but the following is the method I used to pass the Virginia State Electrical Contractor's Exam a few

years ago. This method is merely a suggestion: if another way suits you best, by all means use it.

When the exam booklets were passed out and the applicants were given permission to open them, I spent the first few minutes going over the exam booklet, noting the number of questions. This allowed me to pace myself. I noted there were 100 questions on the morning exam — which gave me less than three minutes to spend on each one.

I then started with question No. 1. When I found one that I wasn't sure of, I merely skipped over this until I came to one that I definitely knew the answer. This way I had gone through the entire test booklet once and had answered about 50% of the questions in a little over one hour. I was quite

sure that I had answered all of these questions correctly. However, 70% is usually the minimum passing grade and at this point, I had only 50% of the questions answered. But I still had about three hours to spend on the tougher questions.

I then started back at the beginning of the exam and went down the list of questions until I found one that was unanswered. This process continued until I had answered all questions to the best of my ability. I spent the remaining time reviewing my previous answers, making changes as necessary.

After lunch, the “afternoon” portion of the exam was handed out, and I used the same procedure as before. I found out a few days later that I had scored 94% on this examination.

What's New In This Edition?

All questions and answers in this book have been updated to comply with the new 2017 *NEC*. Additional questions and answers, along with new illustrations, have been provided to encompass new *NEC* installation requirements. Wherever a change has occurred from the 2014 *NEC*, you will see an icon denoting that a change has been made. This icon appears below.



Chapter 1

Electrical Systems — General Requirements

Owing to the potential fire and explosion hazards caused by the improper handling and installation of electrical wiring, certain rules in the selection of materials, quality of workmanship, and precautions for safety must be followed. To standardize and simplify these rules and provide a reliable guide for electrical construction, the *National Electrical Code*® (*NEC*®) was developed. The *NEC*, originally prepared in 1897, is frequently revised to meet changing conditions, improved equipment and materials, and new fire hazards. It is the result of the best efforts of electrical engineers, manufacturers of electrical equipment, insurance underwriters, fire fighters, and other concerned experts throughout the country.

The *NEC* is now published by the National Fire Protection Association (NFPA), One Batterymarch Park, Quincy, Massachusetts 02169. It contains specific rules and regulations intended to help in the practical safeguarding of persons and property from hazards arising from the use of electricity.

Although the *NEC* itself states, *This Code is not intended as a design specification nor an instruction manual for untrained person*, it does provide

a sound basis for the study of electrical design and installation procedures — under the proper guidance. The probable reason for the *NEC*'s self-analysis is that the code also states, *This Code contains provisions considered necessary for safety. Compliance therewith and proper maintenance will result in an installation essentially free from hazard, but not necessarily efficient, convenient, or adequate for good service or future expansion of electrical use.*

The *NEC*, however, has become the bible of the electrical construction industry, and is usually the basis for most electrician's and electrical contractor's exams. Consequently, anyone involved in electrical work, in *any* capacity, should obtain an up-to-date copy, keep it handy at all times, and refer to it frequently.

To use the *NEC* properly, the definitions listed in Chapter 1, Article 100 of the *NEC* should be fully understood. General requirements for electrical installations are given in Article 110. Then, the remaining Chapters, Articles, and Sections should be studied.

1-1 “Concealed” as applied to electrical wiring means:

- A) Rendered inaccessible by the structure or finish of the building
- B) Capable of being reached quickly
- C) Capable of being removed without damage
- D) Admitting close approach

Answer: A

For example, cables or raceways installed within, say, a drywalled partition are not accessible without damaging the finished wall and are considered to be concealed. Wires in concealed raceways are considered concealed, even though they may become accessible by withdrawing them. NEC Article 100 — Definitions.

1-2 A feeder is:

- A) A circuit conductor between the final overcurrent device protecting the circuit and the outlet
- B) A branch circuit that supplies several outlets
- C) All circuit conductors between the service equipment, the source of a separately derived system, or other power supply source and the final branch-circuit overcurrent device.
- D) A device for generating electricity

Answer: C

NEC Article 100 — Definitions. See Figure 1-1.

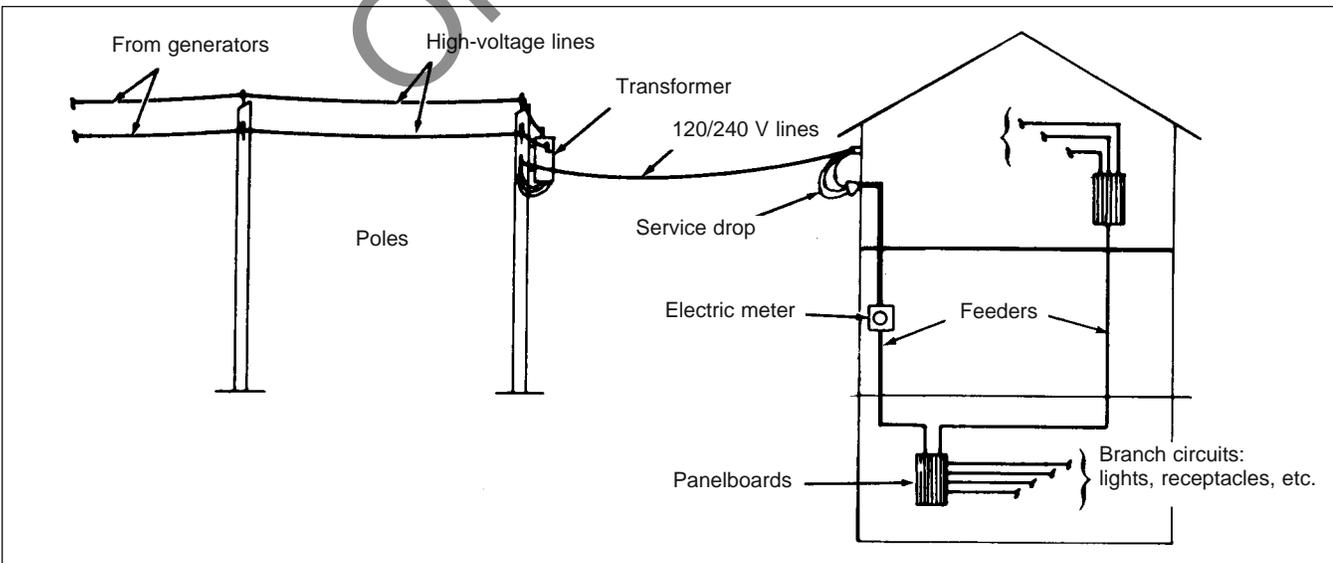


Figure 1-1: Basic electric systems showing service-entrance, feeders to subpanels, and branch circuits

1-3 A bonding conductor or jumper is:

- A) A branch circuit that supplies only one utilization equipment
- B) A reliable conductor to ensure the required electrical conductivity between metal parts required to be electrically connected
- C) An adhesive used to insulate conductors
- D) Capable of being operated without exposing operator to contact with live parts

Answer: B

NEC Article 100 — Definitions. See Figure 1-2.

1-4 In locations where electric equipment would be exposed to physical damage, the following must be provided:

- A) Warning signs
- B) Sufficient headroom
- C) Working space
- D) Enclosures or guards

Answer: D

NEC Section 110.27(B). See Figure 1-3.

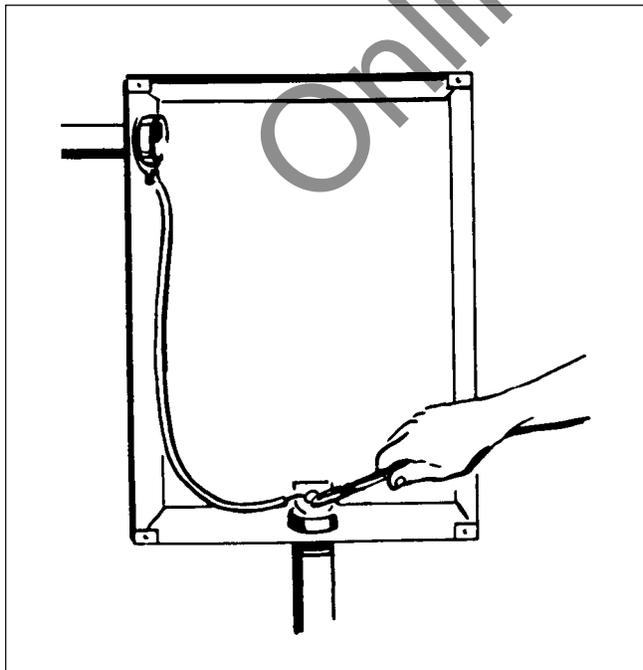


Figure 1-2: Panelboard housing with bonding jumpers

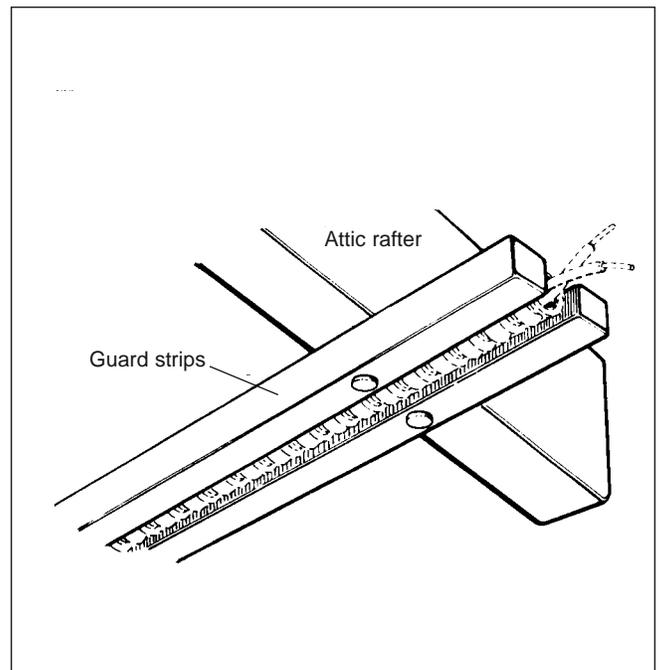


Figure 1-3: Guard strips protecting Type AC cable

1-5 To provide access to the working space about electric equipment, the following number of entrances of sufficient size must be provided:

- A) 3
- B) 2
- C) 1
- D) 4

Answer: C

For example, an electrical equipment room in an office building would require only one entrance door to the room. This entrance shall be capable of giving access to and egress from the working space. NEC Section 110.26(C)(1).

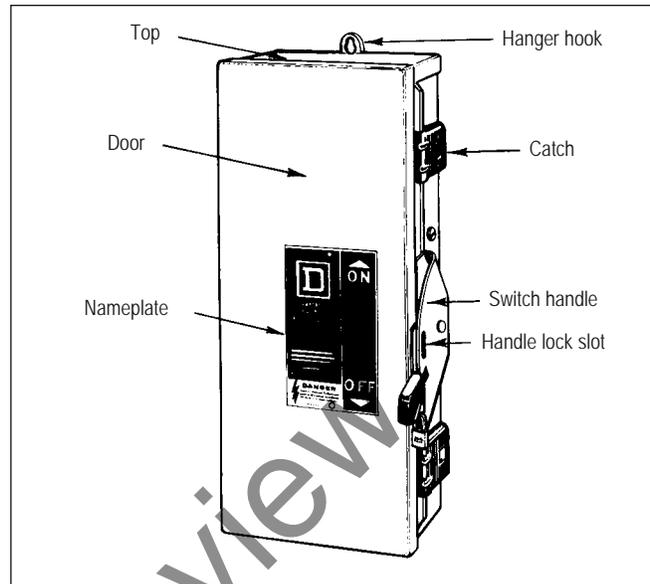


Figure 1-4: Externally-operated safety switch. The live interior parts are fully isolated, but the external handle enables the switch to be operated from the outside.

1-6 Externally operable means:

- A) Capable of being operated from the outside of a building
- B) An apparatus enclosed in a case
- C) Capable of being operated without exposing the operator to contact with live parts
- D) Surrounded by a case

Answer: C

NEC Article 100 — Definitions. See Figure 1-4.

1-7 What must be provided for in all working spaces above service equipment?

- A) A water faucet to flush operator's eyes
- B) A drinking fountain
- C) Illumination
- D) A wash basin

Answer: C

Illumination shall be provided for all working spaces about service equipment, switchboards, switchgear, panelboards, or motor control centers installed indoors. Control by automatic means only shall not be permitted. NEC Section 110.26(D).

1-8 Parts of electric equipment that in ordinary operation produce arcs, sparks, flames, or molten metal shall be enclosed or separated and isolated from:

- | | |
|-----------------------------------|-----------------------|
| A) All other electrical equipment | C) Electric lighting |
| B) All combustible material | D) All working spaces |

Answer: B

NEC Section 110.18. Special rules apply for motors (430.14) and hazardous locations (Articles 500 through 517).

1-9 Working space in rooms containing electrical equipment shall not be used for:

- | | |
|--|----------------------------|
| A) Storage | C) Testing purposes |
| B) Maintenance and repair of equipment | D) Inspection or servicing |

Answer: A

Working space required by this section shall not be used for storage. When normally enclosed live parts are exposed for inspection or servicing, the working space, if in a passageway or general open space, shall be suitably guarded. NEC Section 110.26(B).

1-10 In all cases where there are live parts normally exposed on just the front of switchboards or motor control centers 1000 volts or under, the working space in front of such equipment shall not be less than:

- | | |
|-----------|--|
| A) 1 foot | C) 4 feet unless adequate protection is provided |
| B) 3 feet | D) 18 inches |

Answer: B

Three feet is judged by the NEC to be adequate space so that workers may keep a safe distance from live electrical parts 1000 volts or under, in Condition 1 Situations. NEC Table 110.26(A)(1).



1-11 Ampacity is defined as:

- | | |
|--|--|
| A) The electromotive force required to cause electrons to flow in conductors | C) The maximum current, in amperes, that a conductor can carry continuously under the conditions of use without exceeding its temperature rating |
| B) The amount of power in a circuit | D) The voltage rating of any appliance |

Answer: C

NEC Article 100 — Definitions.

1-12 “Approved” as used in the NEC means:

- A) Acceptable to the authority having jurisdiction
- B) Acceptable only when specified in local ordinances
- C) Okay for use in hazardous locations
- D) Usable only for inside work

Answer: A

In most cases, the local city, county, or state electrical inspector is the “authority” having jurisdiction. NEC Article 100 — Definitions.

1-13 A bare conductor is one with:

- A) Several layers of thermoplastic insulation
- B) Only one layer of insulation
- C) A covering that is not recognized by the NEC as electrical insulation
- D) No covering or insulation whatsoever

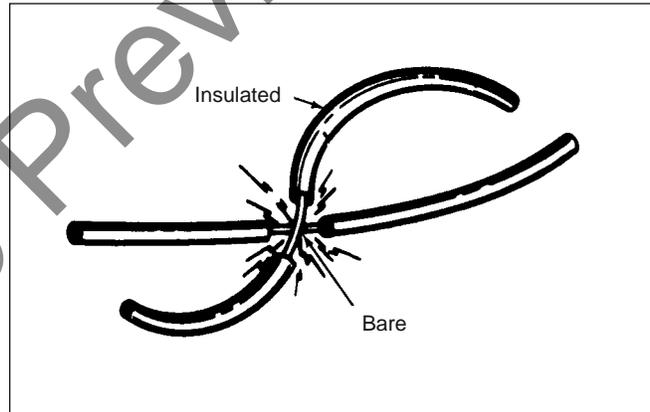


Figure 1-5: Bare conductor compared to one with insulation

Answer: D

A bare conductor, such as a service grounding wire, has no cover or insulation. NEC Article 100 — Definitions, Conductor, Bare. See Figure 1-5.

1-14 Which of the following anchors may not be used to secure electrical equipment to masonry walls?

- A) Lead anchors approved for the weight of the equipment
- B) Toggle bolts
- C) Threaded studs “shot” into the masonry
- D) Wooden plugs driven into holes in the masonry for holding wood screws

Answer: D

NEC Section 110.13(A). See Figure 1-6.

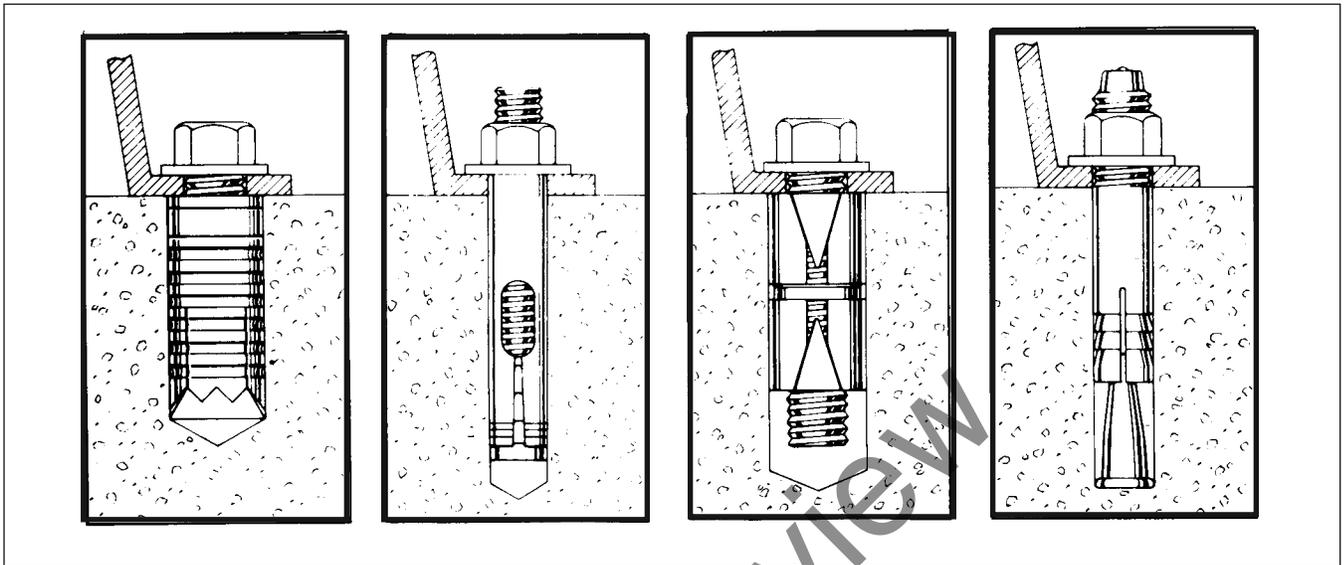


Figure 1-6: Several types of anchors suitable for installing electrical equipment

1-15 A device designed to open and close a circuit by nonautomatic means and to open the circuit automatically on a predetermined overcurrent without damage to itself when properly applied within its rating is called a:

- A) Nonfusible disconnect switch
- B) Time-delay fuse
- C) Circuit breaker
- D) Motor running overcurrent protector

Answer: C

NEC Article 100 — Definitions. See Figure 1-7.

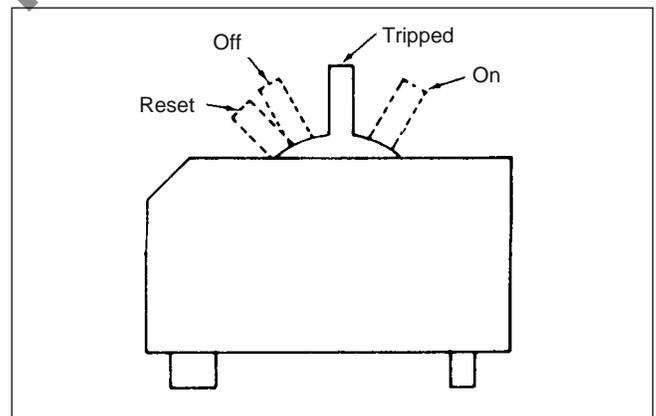


Figure 1-7: Operating characteristics of a circuit breaker

1-16 A conductor encased within material of composition or thickness that is recognized by the *NEC* as electrical insulation is known as:

- A) A bare conductor
- B) A covered conductor
- C) A concealed conductor
- D) An insulated conductor

Answer: D

NEC Article 100 — Definitions, Conductor, Insulated.

1-17 A separate portion of a conduit or tubing system that provides access through a removable cover(s) to the interior of the system at a junction of two or more sections of the system or at a terminal point of the system is defined as a:

- A) Conduit body
- B) Conduit junction
- C) Conduit intersection
- D) Conduit T-connector

Answer: A

NEC Article 100 — Definitions. See Figure 1-8.

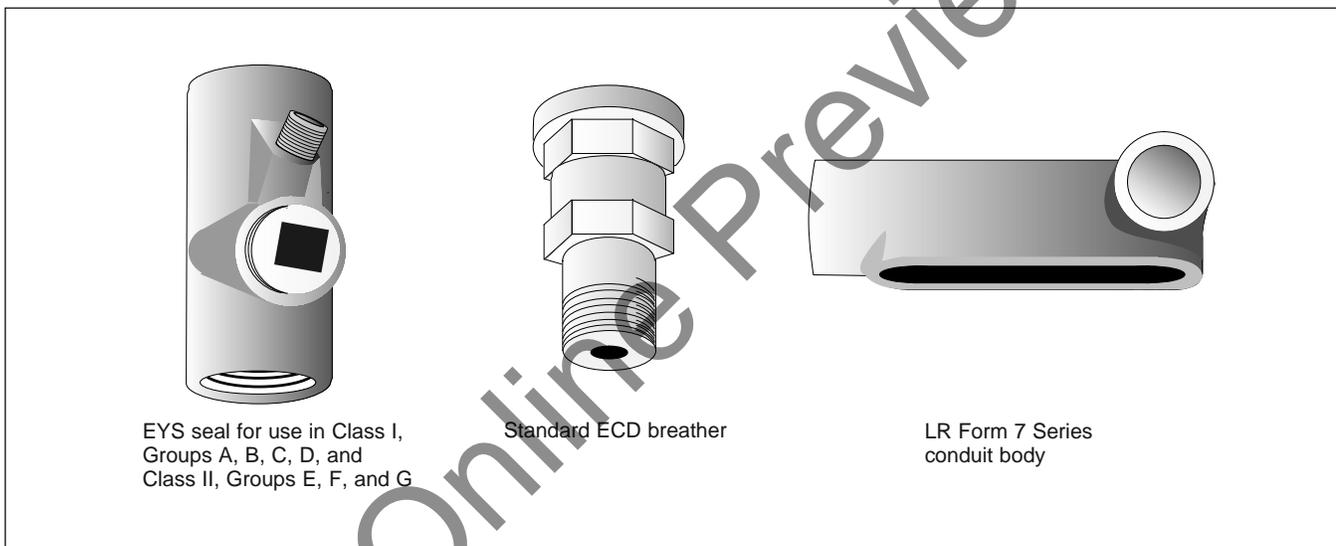


Figure 1-8: Several types of conduit bodies

1-18 What device is now required to detect and protect against arcing in 15- and 20-amp branch circuits supplying outlets installed in dwelling units?

- A) AFCI
- B) GFCI
- C) GFI
- D) AFFI

Answer: A

Outlets installed in dwelling unit kitchens, family rooms, dining rooms, living rooms, laundry rooms. . . or similar rooms or areas shall be protected by a listed arc-fault circuit interrupter, combination-type. NEC Section 210.12(A)(1 through 6). The definition of arc-fault circuit interrupter has been added to Article 100 — Definitions.

1-19 Which circuits must not be connected to any system containing trolley wires with a ground return?

- | | |
|-------------------------|------------------------------------|
| A) Ground wires | C) Circuits for lighting and power |
| B) Grounding conductors | D) Ungrounded trolley wires |

Answer: C

No other “live” or ungrounded conductors may be connected except those specifically designed for trolley operation. NEC Section 110.19.

1-20 The minimum headroom of working spaces about service equipment, switchboards, panelboards, or motor control centers shall be at least:

- | | |
|------------|--------------|
| A) 6½ feet | C) 5.75 feet |
| B) 8 feet | D) 10 feet |

Answer: A

The NEC judges 6½ feet working space, or the height of the equipment, if greater, to be adequate above service equipment to provide room for an electrician to service the equipment. This measurement is taken from the floor to ceiling of, say, an electrical equipment room; not from the top of the panelboard. NEC Section 110.26(A)(3).

1-21 Indoor electrical installations over 1000 volts, nominal, that are open to unqualified persons shall be made with:

- | | |
|---|---|
| A) Open switchgear with readily accessible live parts | C) Provisions to enclose the equipment within a barrier less than 8 feet high |
| B) Metal-enclosed equipment | D) The approval of both the I.B.E.W. and the I.E.S. |

Answer: B

Equipment accessible to unqualified persons shall be metal-enclosed. NEC Section 110.31(B)(1). In addition, associated equipment over 1000 volts, nominal, shall be marked with appropriate danger signs. NEC Section 110.34(C).

1-22 The entrance provided to give access to the working space about electric equipment rated over 1000 volts nominal must not be less than:

- A) 6 feet × 6 feet
- B) 24 feet × 6 feet
- C) 2 feet × 6 feet
- D) 2 feet × 6½ feet

Answer: D

NEC Section 110.33(A). At least one entrance not less than 24 inches wide and 6½ feet high shall be provided to enclosures for electrical installations rated over 1000 volts, as described in 110.31, for access to the working space about electrical equipment. Additionally, door(s) shall open in the direction of egress and be equipped with listed panic hardware. NEC Section 110.33(A)(3).

1-23 Where switches, cutouts or other equipment operating at 1000 volts, nominal, or less, are installed in a room or enclosure where there are exposed energized parts or wiring operating at over 1000 volts, the high-voltage equipment shall generally be effectively separated from the space occupied by the low-voltage equipment by a suitable:

- A) Warning sign
- B) Partition, fence or screen
- C) Voltage-reducing transformer
- D) Firewall



Answer: B

A partition to prevent contact between the two systems must be installed, unless it is accessible to qualified persons only. NEC Section 110.34(B).

1-24 An enclosed channel designed expressly for holding wires, cables, or busbars is called:

- A) A hose
- B) A raceway
- C) A receptacle
- D) A panelboard

Answer: B

A raceway may be conduit or piping, auxiliary wire troughs (gutters), busducts, wire trays, etc. NEC Article 100 — Definitions.

1-25 A contact device installed at the outlet for the connection of an attachment plug is called:

- A) A terminator
- B) A junction box
- C) An overcurrent protection device
- D) A receptacle

Answer: D

NEC Article 100 — Definitions.

1-26 A compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system is a:

- A) Plenum
- B) Duct
- C) Fan-coil unit
- D) Air valve

Answer: A

NEC Article 100 — Definitions. See Figure 1-9.

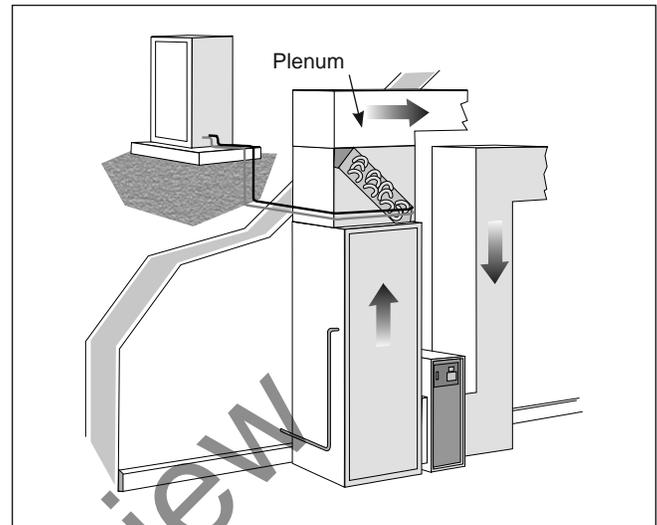


Figure 1-9: An air-distribution system showing a plenum and related air ducts

1-27 The NEC definition of “Qualified Person” is one who:

- A) Has been elected by the Inspection office
- B) Has skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training to recognize and avoid the hazards involved.
- C) Has served two years apprenticeship training with a labor organization
- D) Has a college degree in electrical engineering or electrical technology

Answer: B

A licensed electrician and a professional electrical engineer are two such “qualified” persons. NEC Article 100 — Definitions.

1-28 An unintentional, electrically conductive connection between an ungrounded conductor and the normally non-current-carrying conductors, metallic enclosures, metallic raceways, metallic equipment, or earth, is called:

- A) Arc fault
- B) Stray current
- C) Ground fault
- D) High impedance

Answer: C

NEC Article 100 — Definitions.

1-29 When an enclosure has been constructed or protected so that exposure to a beating rain will not result in the entrance of water under specified test conditions, the enclosure is known as:

- A) Rainproof
- B) Drip-proof
- C) Raintight
- D) Multioutlet assembly

Answer: C

This type of enclosure is designed to keep rain water out of the device. NEC Article 100 — Definitions. See Figure 1-10.



Figure 1-10: A typical raintight enclosure

1-30 A point on the wiring system at which current is taken to supply utilization equipment is known as:

- A) An outlet
- B) A wall switch
- C) A load center
- D) A motor-control center

Answer: A

NEC Article 100 — Definitions.

1-31 The agency that publishes the *NEC* is abbreviated:

- A) HVAC
- B) EEEEC
- C) NFPA
- D) NRA

Answer: C

The National Fire Protection Association.

1-32 A raceway is an enclosed channel designed expressly for holding:

- A) Wires, cables or busbars
 B) Automotive equipment
 C) Spark-plug wires
 D) Equipment for high-speed autos

Answer: A

A conduit, such as rigid steel conduit, unlike plumbing pipe, is designed to contain electrical conductors. A raceway is identified within specific article definitions. NEC Article 100 — Definitions.

1-33 A large single panel, frame, or assembly of panels, on which are mounted on the face, back, or both, switches, overcurrent and other protective devices will fall under the definition of:

- A) General-use switch
 B) Thermal protector
 C) Switchboard
 D) Cutout

Answer: C

Switchboards are generally accessible from the rear as well as from the front and are not intended to be installed in cabinets. NEC Article 100 — Definitions. See Figure 1-11.

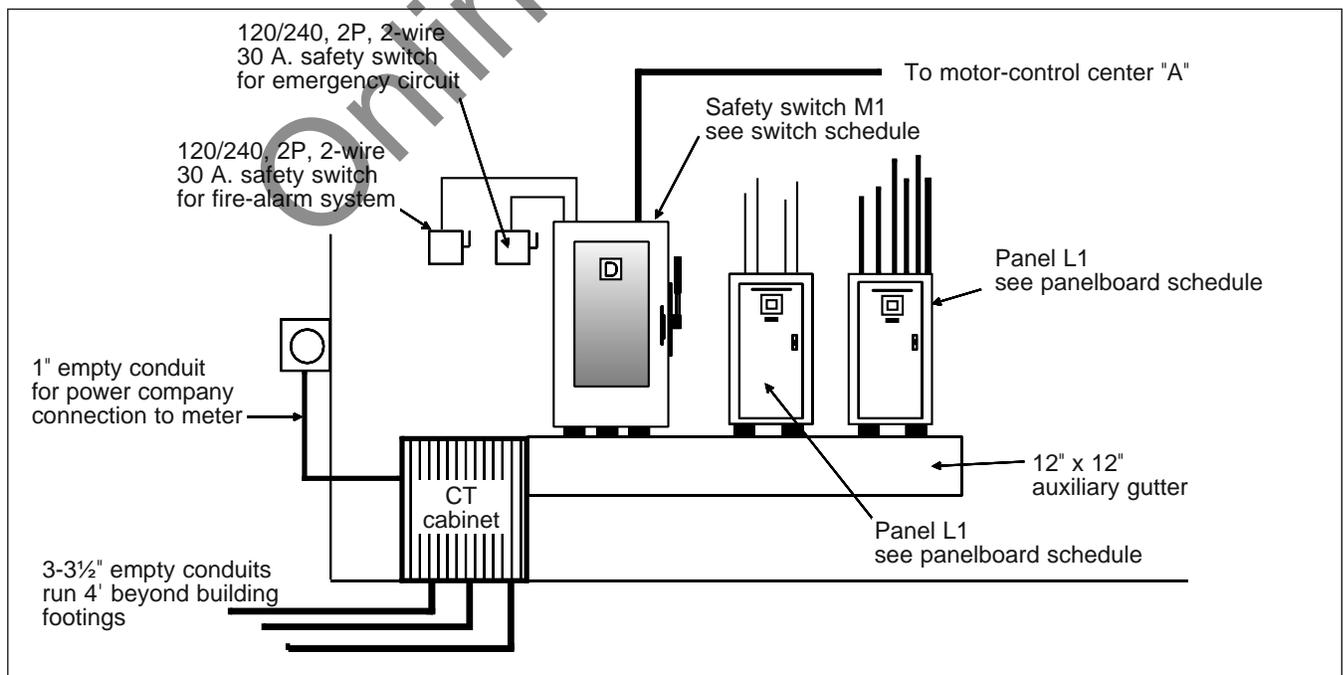


Figure 1-11: An assembly of safety switches, auxiliary gutters, and conduit nipples used for service equipment exactly as they appear on electrical working drawings

1-34 Any electric circuit that controls any other circuit through a relay is called a:

- A) Remote-control circuit
- B) Power circuit
- C) Overload relay
- D) Motor control circuit

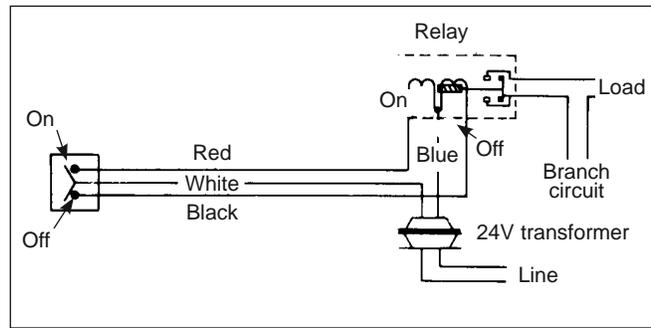


Figure 1-12: Typical remote-control circuit

Answer: A

NEC Article 100 — Definitions. See Figure 1-12.

1-35 Any electric circuit that energizes signaling equipment is known as a:

- A) Low-voltage branch circuit
- B) Multiwire circuit
- C) Signaling circuit
- D) Feeder circuit

Answer: C

For example, a circuit consisting of a low-voltage transformer, pushbuttons, door chime, and conductors is a signaling circuit; so is a security alarm system. NEC Article 100 — Definitions.

1-36 A device that, by insertion in a receptacle, establishes connection between the conductors of the attached flexible cord and the conductors connected permanently to the receptacle is called one of the following:

- A) Female plug
- B) Circuit breaker
- C) Controller
- D) Attachment plug

Answer: D

Also called a plug cap or plug. NEC Article 100 — Definitions. See Figure 1-13.

		15 ampere		20 ampere		30 ampere	
		Receptacle	Plug cap	Receptacle	Plug cap	Receptacle	Plug cap
2 - pole 2 - wire	1 125 V	 1-15R	 1-15P				
	2 250 V		 2-15P	 2-20R	 2-20P	 2-30R	 2-30P
2 - pole 3 - wire grounding	5 125 V	 5-15R	 5-15P	 5-20R	 5-20P	 5-30R	 5-30P
	6 250 V	 6-15R	 6-15P	 6-20R	 6-20P	 6-30R	 6-30P
3 - pole 3 - wire	7 277 V	 7-15R	 7-15P	 7-20R	 7-20P	 7-30R	 7-30P
	10 125/ 250 V			 10-20R	 10-20P	 10-30R	 10-30P
	11* 3 φ Δ 250 V	 11-15R	 11-15P	 11-20R	 11-20P	 11-30R	 11-30P
3 - pole 4 - wire grounding	14* 125/ 250 V	 14-15R	 14-15P	 14-20R	 14-20P	 14-30R	 14-30P
	15* 3 φ Δ 250 V	 15-15R	 15-15P	 15-20R	 15-20P	 15-30R	 15-30P
4 - pole 4 - wire	18 3 φ Y 120/ 208 V	 18-15R	 18-15P	 18-20R	 18-20P	 18-30R	 18-30P

Figure 1-13: Several types of attachment-plug configurations

1-37 A device that establishes a connection between two or more conductors by means of mechanical pressure and without the use of solder is called:

- A) An explosionproof connector with seal-offs
- B) A pressure connector
- C) A wire nut
- D) A shrink connector

Answer: B

NEC Article 100 — Definitions, Connector, Pressure (Solderless). See Figure 1-14.

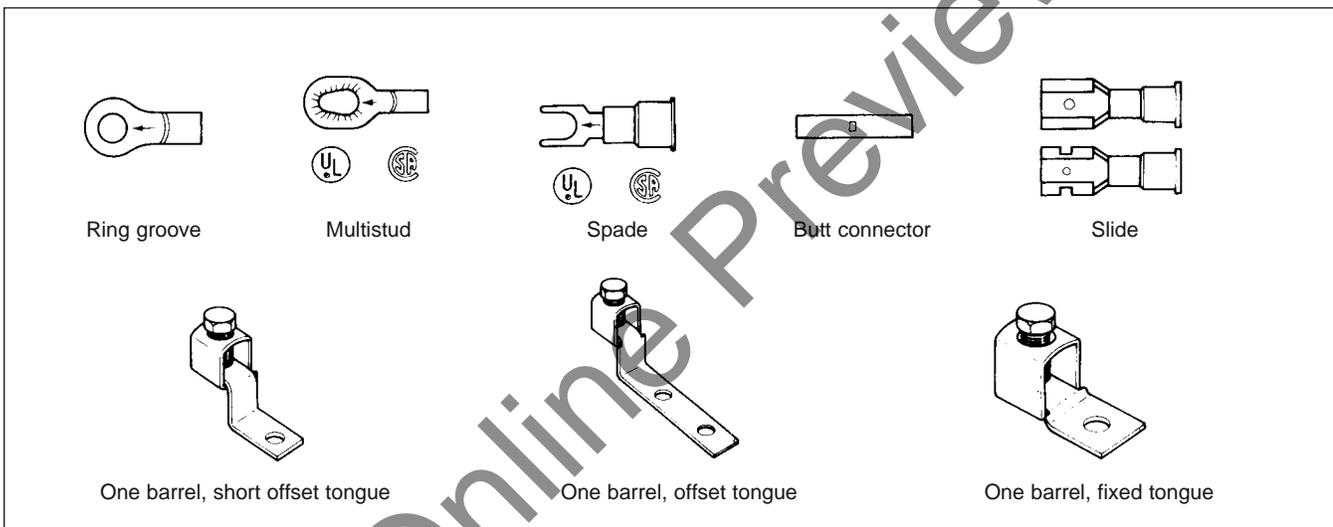


Figure 1-14: Several types of pressure connectors used in electrical work

1-38 A continuous load is a load where the maximum current is expected to continue for a certain length of time. This time is:

- A) One hour or more
- B) Two hours or more
- C) Three hours or more
- D) Four hours or more

Answer: C

For example, electric baseboard heaters in the coldest weather will more than likely operate for longer than three hours. Therefore, circuits feeding these units must be rated as “continuous.” NEC Article 100 — Definitions.

1-39 What is a branch circuit called that supplies a number of outlets for lighting and appliances?

- A) An appliance branch circuit
- B) An individual branch circuit
- C) A general-purpose branch circuit
- D) A multiwire branch circuit

Answer: C

A general purpose branch circuit supplies two or more receptacles or outlets for lighting and appliances. (Circuits feeding any duplex receptacles other than small appliance and laundry equipment are also general purpose branch circuits.) NEC Article 100 — Definitions, Branch Circuit, General-Purpose.

1-40 A device used to govern, in some predetermined manner, the electric power delivered to an electric apparatus is called a:

- A) Controller
- B) Heater
- C) Governor
- D) Motor starter

Answer: A

A wall switch controlling a lighting fixture is one. A motor starter or controller is another example. A rheostat or electronic dimmer used to vary the light intensity is also a controller. NEC Article 100 — Definitions.

1-41 Which of the following qualifying terms indicate that a circuit breaker can be set to trip at various values of current, time, or both, within a predetermined range?

- A) Accessible
- B) Adjustable
- C) Setting
- D) Concealed

Answer: B

The term “adjustable” (as applied to circuit breakers) means that the circuit breaker can be set to trip at various values of current, time, or both, within a predetermined range. NEC Article 100 — Definitions, Circuit Breaker, Adjustable.

1-42 The ratio of the maximum demand of a system, or part of a system, to the total connected load of the system or the part of the system under consideration is known as:

- A) Percentage
- B) Duty cycle
- C) Rated-load current
- D) Demand factor

Answer: D

The NEC recognizes that every electrical outlet or piece of electric equipment will not all be operating simultaneously. Therefore, the NEC allows a demand factor for certain installations. NEC Article 100 — Definitions.

1-43 Electric parts that are not suitably guarded, isolated, or insulated and are capable of being inadvertently touched or approached nearer than a safe distance by a person are known as:

- A) Exposed
- B) Externally operable
- C) Accessible
- D) Dead front

Answer: A

A switchboard with knife switches, for example, has exposed live electrical parts. NEC Article 100 — Definitions.

1-44 A device intended for the protection of personnel that functions to de-energize a circuit or portion thereof within an established period of time when a current to ground exceeds the values established for a class A device.

- A) Grounding electrode device
- B) Ground-fault circuit-interrupter (GFCI)
- C) Guarded protector
- D) Thermal cutout

Answer: B

Class A GFCIs trip when the current to ground is 6 mA or higher. Ground-fault circuit-interrupters are required on all residential receptacles installed outdoors, in bathrooms and kitchens, and in garages, etc. NEC Article 100 — Definitions. See Figure 1-15.

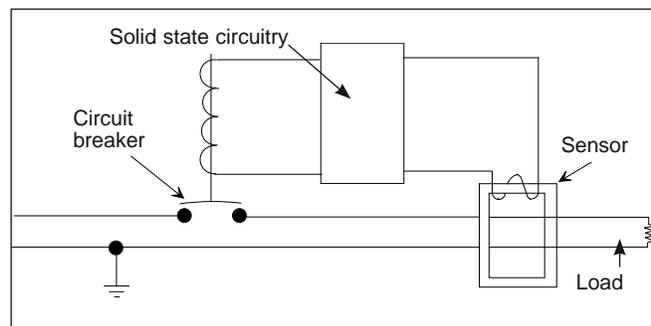


Figure 1-15: Ground-fault circuit-interrupter circuit

1-45 The NEC uses the term “isolated” to mean:

- | | |
|---|---|
| A) Not readily accessible to persons unless special means for access are used | C) Identifiable by means of color coding or nameplate |
| B) Grouped together | D) Nearby |

Answer: A

For example, a safety switch with a means of locking the access door to live interior parts would be considered to be not readily accessible. NEC Article 100 — Definitions.

1-46 Accessories such as locknuts, bushings, etc. are known as:

- | | |
|-------------------|-----------------|
| A) Connectors | C) Fittings |
| B) Conduit bodies | D) Ground clips |

Answer: C

A fitting can be a locknut, bushing, or other part of a wiring system that is intended to perform a mechanical rather than an electrical function. NEC Article 100 — Definitions.

1-47 An arrangement of incandescent lamps or electric discharge lighting to call attention to certain features such as the shape of a building is called:

- | | |
|---|---|
| A) Festoon lighting used for outdoor parties and to highlight other outdoor functions | C) High-intensity discharge lighting such as normally used at intersections of highways |
| B) Outline lighting | D) Decorative lighting inside a building |

Answer: B

Lighting fixtures of many types, but especially neon, are used to highlight signs, buildings, and the like. Las Vegas gambling casinos are a good example of how outline lighting is used to highlight and outline buildings or windows. NEC Article 100 — Definitions.

1-48 Operation of equipment in excess of normal, full-load rating is known as:

- A) Hot load
- B) Under current
- C) Overload
- D) Periodic duty

Answer: C

For example, a conductor operating in excess of its rated ampacity that, if it persists for a sufficient length of time, would cause damage or dangerous overheating. A fault, such as a short circuit or ground fault, is not an overload. NEC Article 100 — Definitions.

1-49 The value of current, time, or both at which an adjustable circuit breaker is set to trip is known as:

- A) Inverse time
- B) Ampacity
- C) Automatic
- D) Setting

Answer: D

The setting of a circuit breaker is the value of current, time, or both at which an adjustable circuit breaker is set to trip. NEC Article 100 — Definitions, Circuit Breaker, Setting.

1-50 Which of the following must not be allowed to come in contact with interior parts of electrical equipment?

- A) Busbars
- B) Wiring terminals
- C) Abrasives
- D) Insulators

Answer: C

NEC Section 110.12(B) states that internal parts of electrical equipment must not be damaged or contaminated by foreign materials such as paint, plaster, cleaners, abrasives or corrosive residues.

1-51 How tall must a wall, screen, or fence be that encloses an outdoor electrical installation over 1000 volts nominal to deter access by unqualified persons?

- A) 5 feet
- B) 6 feet
- C) 7 feet
- D) 8 feet

Answer: C

NEC Section 110.31 requires a wall, screen, or fence to be not less than 7 feet in height when it is used to enclose an outdoor electrical installation with voltages over 1000 volts nominal.

1-52 Entrances to all rooms or other enclosures containing exposed live parts operating at over 1000 volts, nominal, shall be:

- A) Elevated 30 feet above ground
- B) Painted yellow with black and blue stripes
- C) Kept unlocked for immediate servicing
- D) Kept locked

Answer: D

NEC Section 110.34(C) requires that entrances to all buildings, vaults, rooms, or enclosures containing exposed live parts or exposed conductors operating at over 1000 volts, nominal, be kept locked unless such entrances are under the observation of a qualified person at all times. In addition, permanent “danger” signs shall be provided that meet the requirements in NEC Section 110.21(B).

1-53 A “bathroom” is an area that includes a basin with one or more of the following:

- A) Exhaust fan
- B) AFCI
- C) Closet
- D) Bidet

Answer: D

The definition of “bathroom” was revised in 2011 to include “a urinal” and “a bidet, or similar plumbing fixtures.” NEC Article 100 — Definitions.

1-54 Which of the following best describes festoon lighting?

- A) A string of outdoor lights that is suspended between two points C) Low voltage lighting used on billboards
B) A 600 volt lighting system used in power plants D) Underwater lighting in pools and ponds

Answer: A

Defined in NEC Article 100 — Definitions.

1-55 What is the term used to describe an enclosure constructed so that dust will not enter under specified test conditions?

- A) Dustproof C) Dusttight
B) Dust prevention D) Explosionproof

Answer: C

NEC Article 100 — Definitions.

1-56 What is an assembly of one or more enclosed sections having a common power supply (bus) and principally containing motor control units called?

- A) Main distribution panel C) Motor load center
B) Motor control center D) Selector-switch control center

Answer: B

NEC Article 100 — Definitions states that the described apparatus is referred to as a “motor control center.” See Figure 1-16.

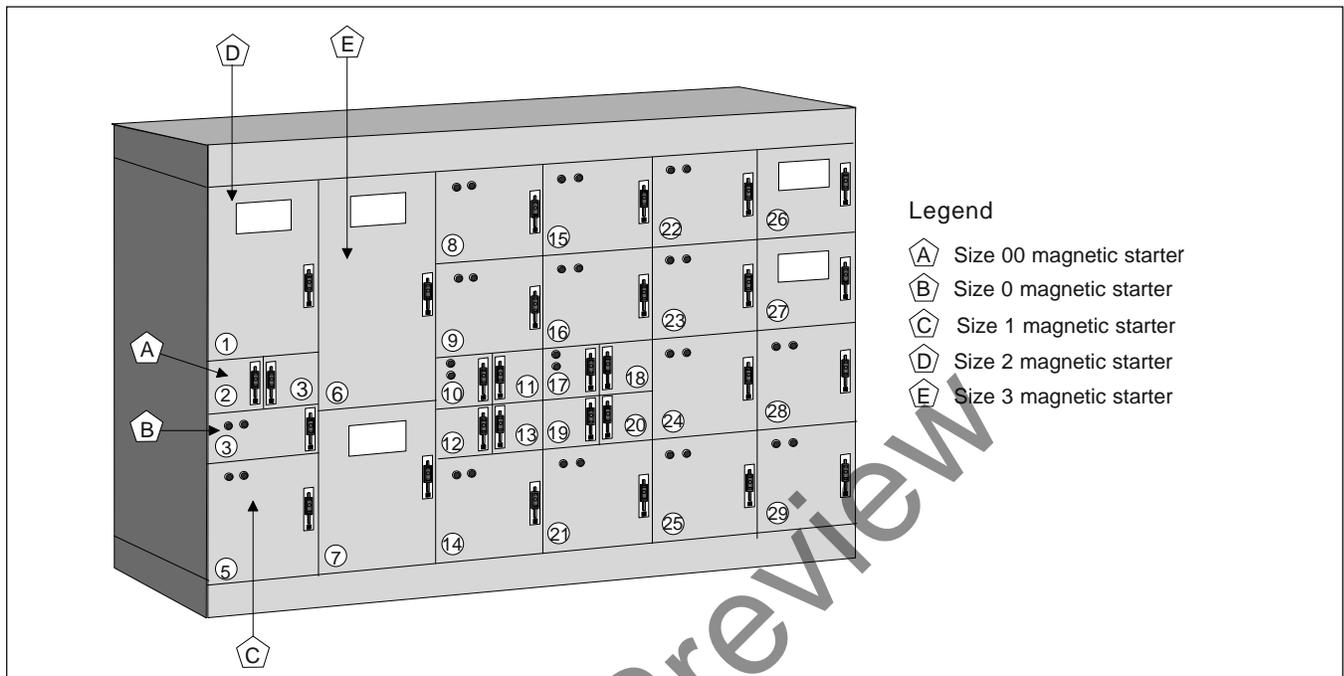


Figure 1-16: Typical motor control center

1-57 What is the name of an electrical load where the wave shape of the steady-state current does not follow the wave shape of the applied voltage?

- A) Linear
 B) Parallel load
 C) Nonlinear load
 D) Series load

Answer: C

NEC Article 100 — Definitions.

1-58 How many access entrances are required to working space about electrical equipment rated 1200 amperes or more and over 6 feet wide?

- A) One
 B) Two, one at each end of the area
 C) Three, one on each of three sides
 D) Four, one on each of four sides

Answer: B

NEC Section 110.26(C)(2) requires one entrance not less than 24 inches wide and 6½ feet high at each end of the work space to allow entrance to and egress from the work space. Additional requirements apply to the installation and hardware requirements of such doors.

1-59 When the electrical equipment exceeds 6½ feet in height, what is the required minimum headroom?

- | | |
|---|---|
| A) One foot higher than the top of the highest piece of equipment | C) 6 inches more than the height of the equipment |
| B) Not less than the height of the equipment | D) 4 feet more than the height of the equipment |

Answer: B

NEC Section 110.26(A)(3) requires a minimum headroom working space of 6½ feet; the minimum headroom shall not be less than the height of the equipment if the equipment exceeds 6½ feet in height.

1-60 Where must branch circuits and feeders be identified?

- | | |
|--------------------------------------|--|
| A) At the disconnecting means | C) At both the point where they originate and the point where they terminate |
| B) At the point where they terminate | D) Midway between the outlet and overcurrent protective device |

Answer: A

NEC Section 110.22 requires circuit identification at the disconnecting means. This is usually at the main distribution panel for feeders and at subpanels for branch circuits. If overcurrent protective devices are located properly, this is the location where the circuits should be identified. The marking shall be able to withstand the environment involved.

1-61 What is the minimum depth of clear working space at electrical equipment rated above 75 kV and classified as Condition 1?

- | | |
|-----------|-----------|
| A) 3 feet | C) 6 feet |
| B) 5 feet | D) 8 feet |

Answer: D

NEC Table 110.34(A) requires 8 feet minimum depth of clear working space under the conditions described in this question.

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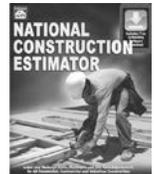
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