Preface

The *National Electrical Code* is a model code written in technical, legal language. To work in the electrical trades, it is critical that you learn the *NEC*'s structure, how to navigate it, and how to identify and use tables correctly. Because the *NEC* is revised every three years, it is vital that you understand how the information is organized rather than memorizing locations that might change. *Cracking the Code* was written to help you understand how to use the *NEC*. This text will teach you how to navigate and find information by focusing on the structure and organization of the *NEC*.

Part 1 of this text will break down the structure of the *NEC*, instructing on the layout and focusing on each chapter of the *NEC*, one at a time. Part 2 of this text delves into applying the knowledge learned in Part 1, providing you an opportunity to apply your knowledge of the *NEC* to find the necessary information to complete a task.

Extensive practice problems apply and reinforce *NEC* knowledge. End-of-unit problems start out as simple multiple-choice questions that reinforce the material learned within the unit and advance to open-ended questions that build off what was learned in previous units.

About the Author

Rob Zachariason has worked in the electrical industry for over 30 years. He is currently an instructor in the Electrical Technology program at Minnesota State Community and Technical College in Moorhead, Minnesota. He was formerly an instructor for the Dakotas JATC in Fargo, North Dakota. When not in school, Mr. Zachariason is the working owner of Rob Zachariason Electric. Mr. Zachariason has also worked on several electrical textbooks as well as instructor supplements and videos.

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Reviewers

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The *National Electrical Code*®

The most informative and authoritative body of information concerning electrical wiring installation in the United States, and perhaps the world, is the *National Electrical Code*® (*NEC*). This code establishes a set of rules, regulations, and criteria for the installation of electrical equipment. Compliance with these methods will result in a safe installation.

The *NEC* is drafted by a team of experts assembled for this purpose by the National Fire Protection Association (NFPA). This team is formally called the *National Electrical Code* committee. They revise and update the *NEC* every three years. It is imperative that anyone installing electrical wiring obtains and studies the *NEC*. Articles and sections of the *NEC* are referred to throughout this text. Although certain portions, tables, and examples are directly quoted from its text, there is enough useful information in the *NEC* that not having it available would be a tremendous hindrance.

The latest edition of the *National Electrical Code* can be purchased from the National Fire Protection Association by visiting their website. Online access to the *National Electrical Code* and over 1,400 NFPA codes and standards is available with an NFPA LiNK® subscription. NFPA LiNK includes all current editions as well as a library of legacy codes and standards going back five editions. Subscribers also have early access to newly released editions before the printed book is available for purchase. To learn more about NFPA LiNK, visit the NFPA website at www.nfpa.org.

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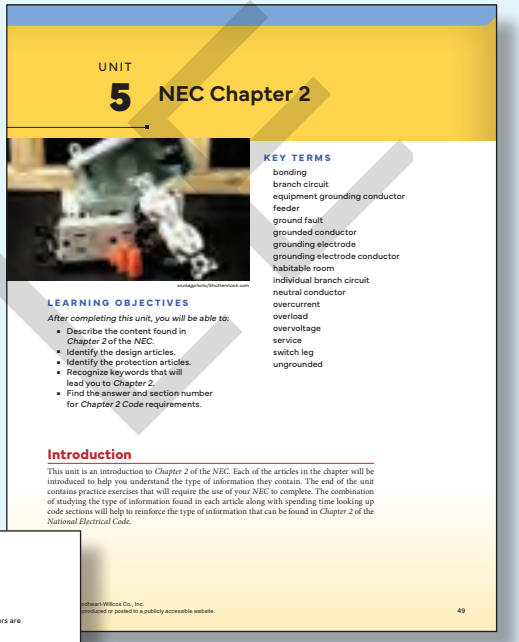
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Features of the Textbook

The instructional design of this textbook includes student-focused learning tools to help you succeed. This visual guide highlights these features.

Unit Opening Materials

Each unit opener contains a list of learning objectives, a list of technical terms, and a brief introduction.
Learning Objectives clearly identify the knowledge and skills to be gained when the unit is completed.
Key Terms list the key words to be learned in the unit.
Introduction provides an overview and preview of the unit content.



UNIT
5 NEC Chapter 2

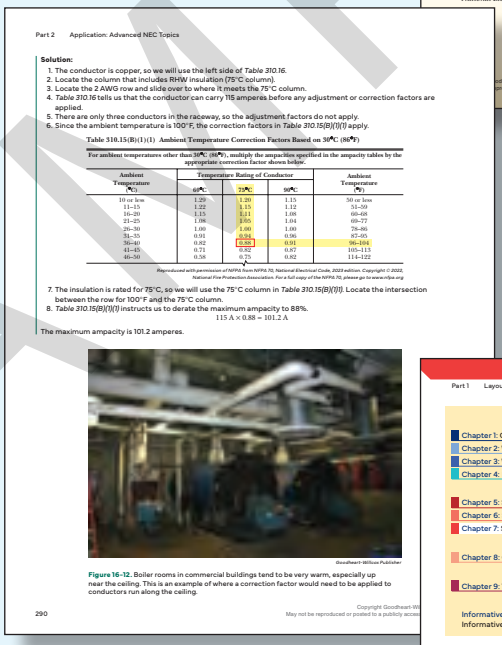
KEY TERMS
bonding
branch circuit
equipment grounding conductor
feeder
ground fault
grounded conductor
grounding electrode
grounding electrode conductor
habitable room
individual branch circuit
neutral conductor
overcurrent
overload
overvoltage
service
switch leg
ungrounded

LEARNING OBJECTIVES
After completing this unit, you will be able to:
- Describe the content found in *Chapter 2* of the *NEC*.
- Identify the design articles.
- Identify the protection articles.
- Recognize keywords that will lead you to *Chapter 2*.
- Find the answer and section number for *Chapter 2* Code requirements.

Introduction
This unit is an introduction to *Chapter 2* of the *NEC*. Each of the articles in the chapter will be introduced to help you understand the type of information they contain. The end of the unit contains practice exercises that will require the use of your *NEC* to complete. The combination of studying the type of information found in each article along with spending time looking up code sections will help to reinforce the type of information that can be found in *Chapter 2* of the *National Electrical Code*.

Additional Features

Additional features are used throughout the body of each unit to further learning and knowledge.
Examples provide step-by-step sample problems that demonstrate how to perform calculations.
Procedures are highlighted throughout the textbook to provide clear instructions for various processes. **Pro Tips** provide advice and guidance that is especially applicable for on-the-job situations.
Navigation Tables highlight all the sections contained within some of the most-used articles of the *NEC*. This type of overview, which is not provided in the *NEC*, helps students understand the type of information contained in those articles.



Part 2 Application: Advanced NEC Topics

Solution:
1. The conductor is copper, so we will use the left side of *Table 310.16*.
2. Locate the column that includes RHW insulation (75°C column).
3. Locate the 2 AWG row and slide over to where it meets the 75°C column.
4. *Table 310.16* tells us that the conductor can carry 115 amperes before any adjustment or correction factors are applied.
5. There are only three conductors in the raceway, so the adjustment factors do not apply.
6. Since the ambient temperature is 100°F, the correction factors in *Table 310.15(B)(1)(1)* apply.

Table 310.15(B)(1)(1) Ambient Temperature Correction Factors Based on 30°C (86°F)

For ambient temperatures other than 30°C (86°F), multiply the ampacities specified in the ampacity tables by the appropriate correction factor shown below.

Ambient Temperature (°C)	Temperature Rating of Conductor 60°C	75°C	90°C	Ambient Temperature (°F)
10 or less	1.29	1.20	1.15	50 or less
11–15	1.22	1.15	1.12	51–59
16–20	1.15	1.13	1.08	60–68
21–25	1.08	1.05	1.04	69–77
26–30	1.00	1.00	1.00	78–86
31–35	0.91	0.94	0.96	87–95
36–40	0.82	0.88	0.91	96–104
41–45	0.71	0.82	0.87	105–113
46–50	0.58	0.75	0.82	114–122

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7. The insulation is rated for 75°C, so we will use the 75°C column in *Table 310.15(B)(1)(1)*. Locate the intersection between the row for 100°F and the 75°C column.
8. *Table 310.15(B)(1)(1)* instructs us to derate the maximum ampacity to 88%.

$$115 \text{ A} \times 0.88 = 101.2 \text{ A}$$

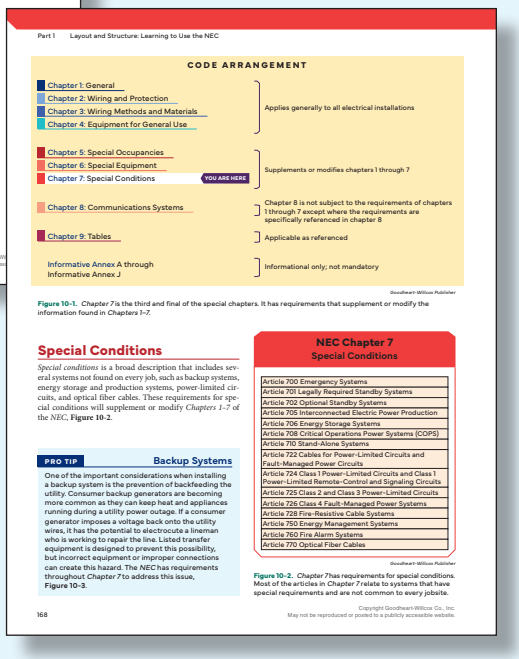
The maximum ampacity is 101.2 amperes.

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Figure 16-12. Boiler rooms in commercial buildings tend to be very warm, especially up near the ceiling. This is an example of where a correction factor would need to be applied to conductors run along the ceiling.

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Part 1 Layout and Structure: Learning to Use the NEC

CODE ARRANGEMENT

Chapter 1: General Chapter 2: Wiring and Protection Chapter 3: Wiring Methods and Materials Chapter 4: Equipment for General Use	Applies generally to all electrical installations
Chapter 5: Special Occupancies Chapter 6: Special Equipment Chapter 7: Special Conditions YOU ARE HERE	Supplements or modifies chapters 1 through 7
Chapter 8: Communications Systems	Chapter 8 is not subject to the requirements of chapters 1 through 7 except where the requirements are specifically referenced in chapter 8
Chapter 9: Tables	Applicable as referenced
Informative Annex A through Informative Annex J	Informational only; not mandatory

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Figure 10-1. *Chapter 7* is the third and final of the special chapters. It has requirements that supplement or modify the information found in *Chapters 1–7*.

Special Conditions
Special conditions is a broad description that includes several systems not found on every job, such as backup systems, energy storage and production systems, power-limited circuits, and optical fiber cables. These requirements for special conditions will supplement or modify *Chapters 1–7* of the *NEC*, **Figure 10-2**.

PRO TIP Backup Systems
One of the important considerations when installing a backup system is the prevention of backfeeding the utility. Consumer backup generators are becoming more common as they can keep heat and appliances running during a utility power outage. If a consumer generator imposes a voltage back onto the utility wires, it has the potential to electrocute a lineman who is working to repair the line. Listed transfer equipment is designed to prevent this possibility, but incorrect equipment or improper connections can create this hazard. The *NEC* has requirements throughout *Chapter 7* to address this issue, **Figure 10-3**.

NEC Chapter 7
Special Conditions

Article 700 Emergency Systems
Article 701 Legally Required Standby Systems
Article 702 Optional Standby Systems
Article 705 Interconnected Electric Power Production
Article 706 Energy Storage Systems
Article 708 Critical Operations Power Systems (COPS)
Article 710 Stand-Alone Systems
Article 722 Cables for Power-Limited Circuits and Fault-Managed Power Circuits
Article 724 Class 1 Power-Limited Circuits and Class 1 Power-Limited Remote-Control and Signaling Circuits
Article 725 Class 2 and Class 3 Power-Limited Circuits
Article 726 Class 4 Fault-Managed Power Systems
Article 728 Fire-Resistive Cable Systems
Article 750 Energy Management Systems
Article 760 Fire Alarm Systems
Article 770 Optical Fiber Cables

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Figure 10-2. *Chapter 7* has requirements for special conditions. Most of the articles in *Chapter 7* relate to systems that have special requirements and are not common to every jobsite.

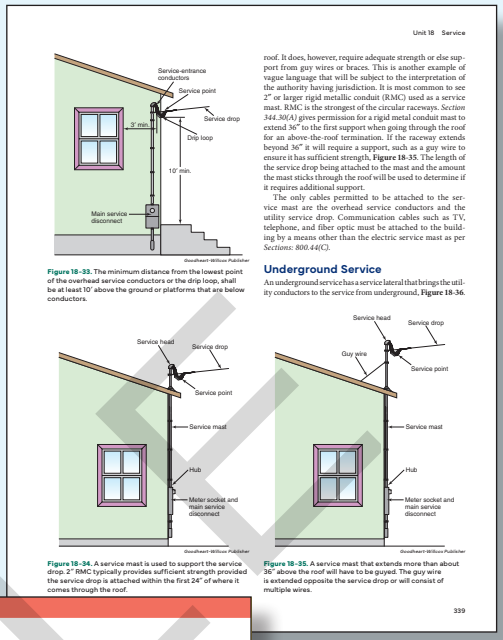
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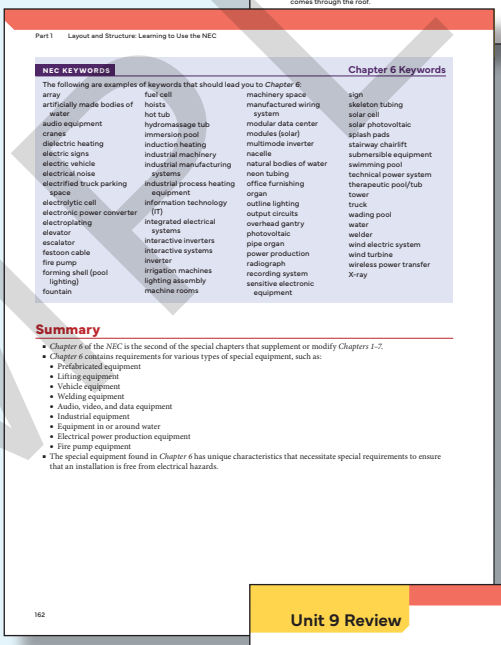
Illustrations

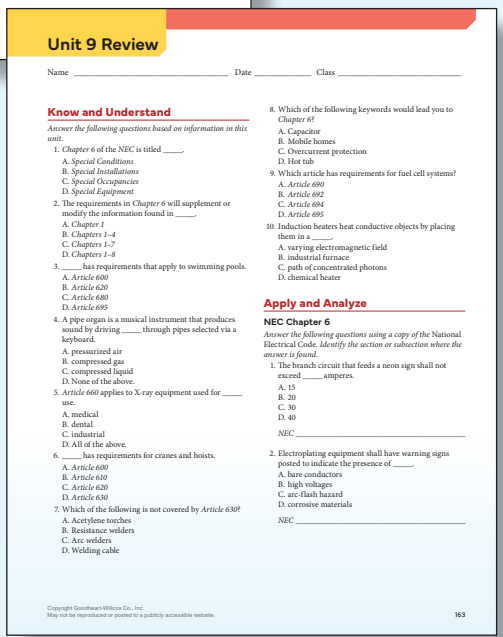
Illustrations have been designed to clearly and simply communicate the specific topic. Illustrations and photographic images have been carefully chosen and designed to reinforce the text's content. Excerpts from the *NEC* are provided to give students real examples and visuals.



End-of-Unit Content

End-of-unit material provides an opportunity for review and application of concepts. **NEC Keywords** list numerous topics and words that should lead the user to a particular chapter of the *NEC*. A concise **Summary** provides an additional review tool and reinforces key learning objectives. This helps you focus on important concepts presented in the text. **Know and Understand** questions enable you to demonstrate knowledge, identification, and comprehension of unit material. **Apply and Analyze** questions extend learning and require you to select an answer by finding the correct section within the *NEC*. **Critical Thinking** questions are open ended and require you to find the answer and correct section within the *NEC*. These questions will begin testing you on the content contained within that unit and become cumulative, basing questions on everything learned up to that point within the text.





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TOOLS FOR STUDENT AND INSTRUCTOR SUCCESS

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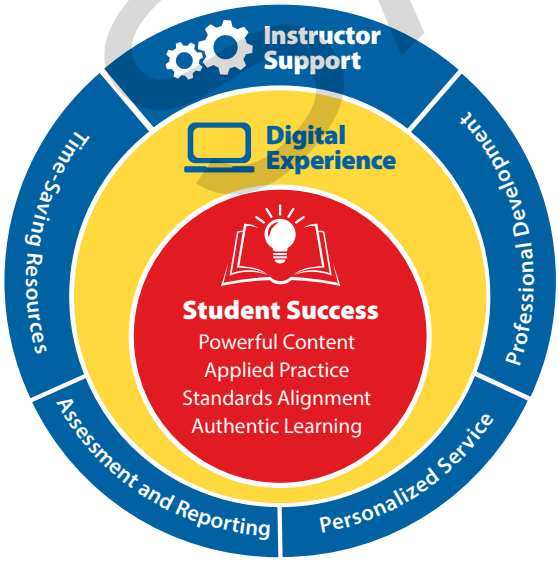
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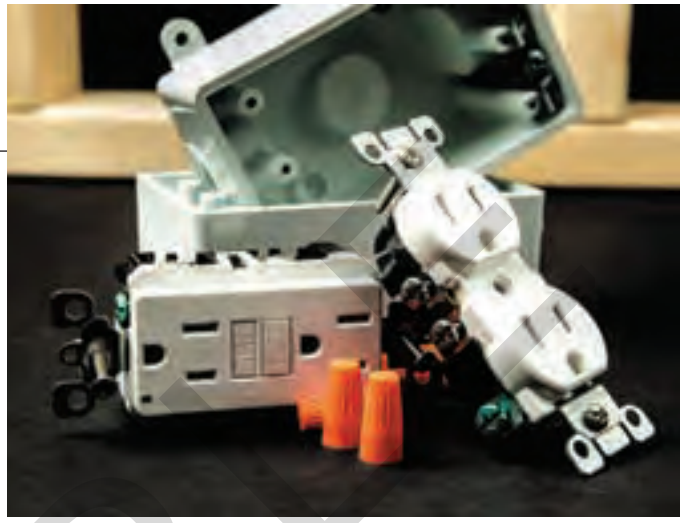
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