

ELECTRICAL WIRING

16th
EDITION



COMMERCIAL

BASED ON THE 2017 NATIONAL ELECTRICAL CODE®



Phil Simmons
Ray C. Mullin



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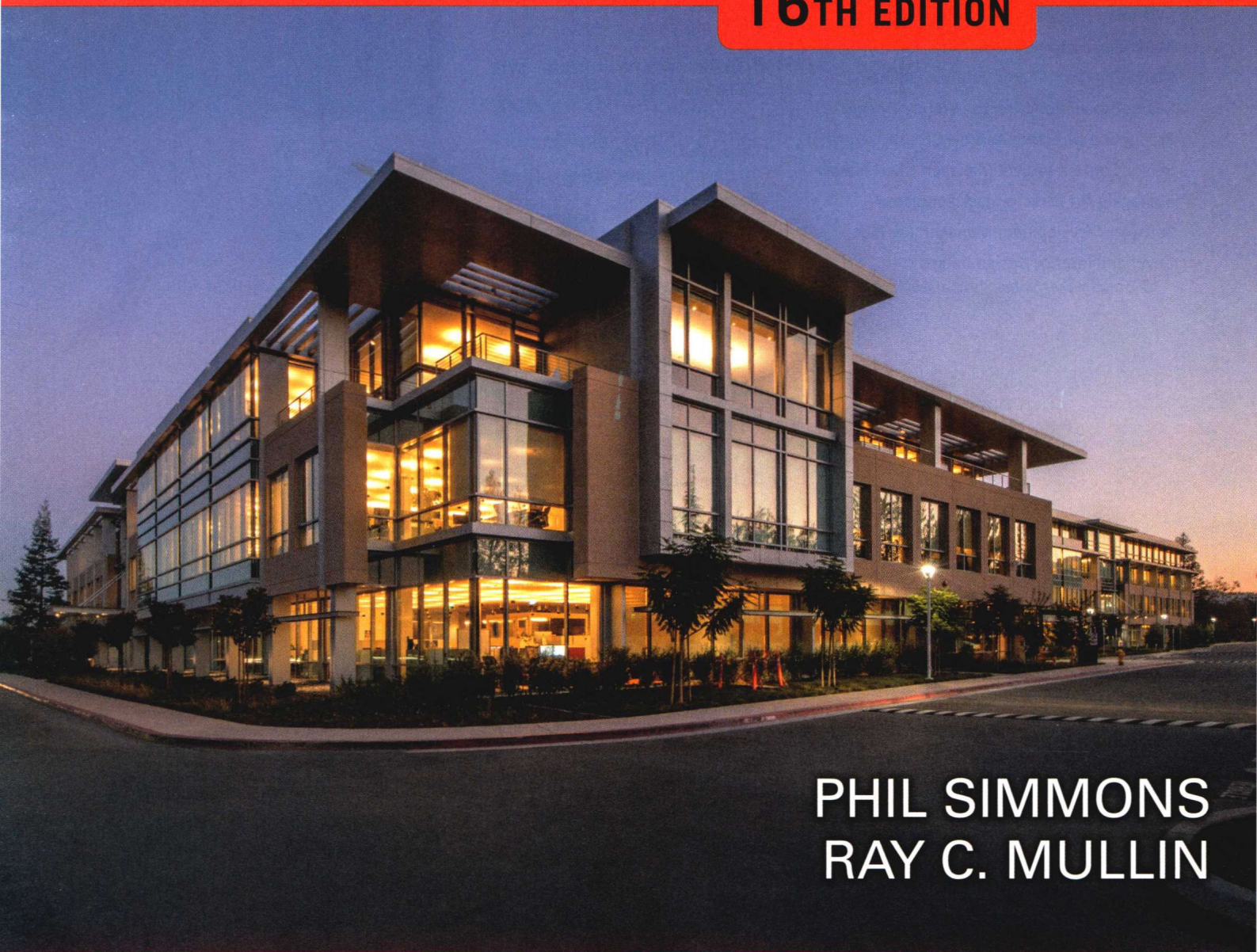


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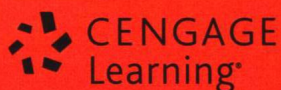


Based on the 2017 National Electrical Code®

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**PHIL SIMMONS
RAY C. MULLIN**



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Electrical Wiring Commercial, 16th Edition

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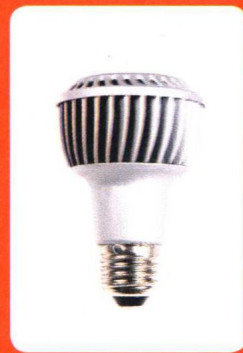
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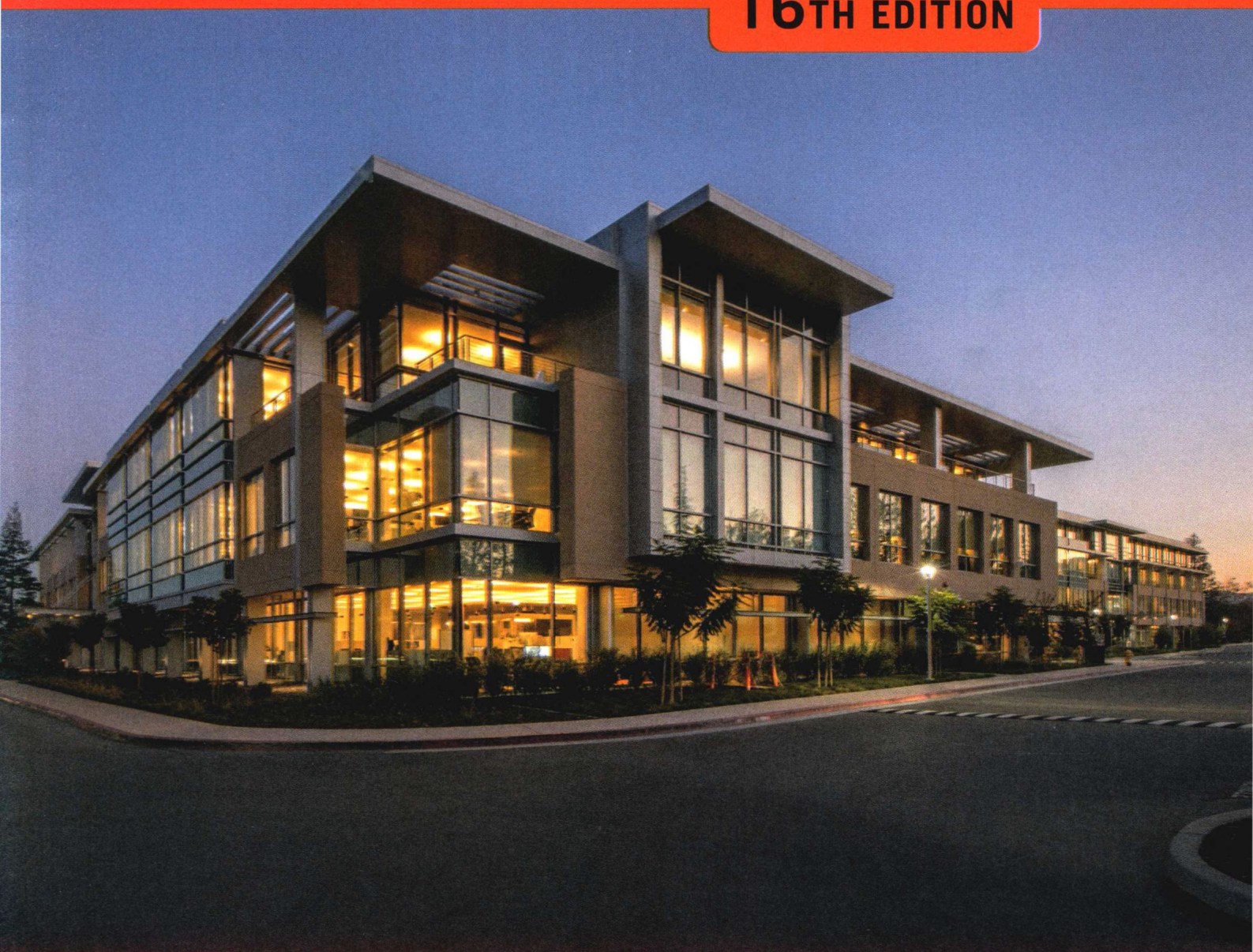
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ELECTRICAL WIRING COMMERCIAL



Based on the 2017 National Electrical Code®

16TH EDITION





Preface

■ Intended Use and Level

Electrical Wiring—Commercial is intended for use in commercial wiring courses at two-year and four-year colleges, as well as in apprenticeship training programs. The text provides the basics of commercial wiring by offering insight into the planning of a typical commercial installation, carefully demonstrating how the load requirements are converted into branch circuits, then to feeders, and finally into the building's main electrical service. An accompanying set of plans at the back of the book allows the reader to step through the wiring process by applying concepts learned in each chapter to an actual commercial building, in order to understand and meet *Code* requirements set forth by the *National Electrical Code*®.

■ Subject and Approach

The sixteenth edition of *Electrical Wiring—Commercial* is based on the 2017 *National Electrical Code*. This new edition thoroughly and clearly explains the *NEC*® changes that relate to typical commercial wiring.

The *National Electrical Code* is used as the basic standard for the layout and construction of electrical systems. To gain the greatest benefit from this text, the learner must use the *National Electrical Code* on a continuing basis.

State and local codes may contain modifications of the *National Electrical Code* to meet local requirements. The instructor is encouraged to furnish students with any variations from the *NEC* as they affect this commercial installation in a specific area.

This book takes the learner through the essential minimum requirements as set forth in the *National Electrical Code* for commercial installations. In addition to *Code* minimums, the reader will find such information above and beyond the minimum requirements.

The commercial electrician is required to work in three common situations: where the work is planned in advance, where there is no advance planning, and where repairs are needed. The first situation exists when the work is designed by a consulting engineer or by the electrical contractor as part of a design/build project. In this case, the electrician must know the installation procedures, be able to read and follow the plans for the project, be able to understand and interpret specifications, and must know the applicable *Code* requirements. The second situation occurs either during or after construction when changes or remodeling are required. The third situation arises any time after a system is installed. Whenever a problem occurs with an installation, the electrician must understand the operation of all equipment included in the installation in order to solve the problem. And as previously stated,

all electrical work must be done in accordance with the *National Electrical Code* and any local electrical codes.

The electrician must understand that he or she is a part of a construction team with the goal of getting the project completed on time and within the budget. Cooperation and “pulling your load” are the keys to success. The general contractor and owner count on every trade and specialist to get the components on the job when they are needed and install them so as to keep the project moving ahead smoothly.

When the electrician is working on the initial installation or is modifying an existing installation, the circuit loads must be determined. Thorough explanations and numerous examples of calculating these loads help prepare the reader for similar problems on the job. The text and assignments make frequent reference to the Commercial Building drawings at the back of the book.

The electrical loads (lighting, outlets, equipment, appliances, etc.) were selected to provide the reader with experiences that he or she would encounter when wiring a typical commercial building. The authors also carry many calculations to a higher level of accuracy as compared to the accuracy required in many actual job situations. This is done to demonstrate the correct method according to the *National Electrical Code*. Then, if the reader and/or the instructor wish to back off from this level, based upon installation requirements, it can be done intelligently.

Features

- **Safety** is emphasized throughout the book and fully covered in the first chapter. Special considerations in working with electricity, such as how to avoid arc flash, as well as guidelines for safe practices, provide readers with an overview of what dangers are to be expected on the job.
- **Commercial Building Drawings** are included in the back of the book, offering readers the opportunity to apply the concepts that they have learned in each chapter as they step through the wiring process. A description of working

drawings and an explanation of symbols can be found in the first chapter.

- **National Electrical Code** references are integrated throughout the chapters, familiarizing readers with the requirements of the *Code* and including explanations of the wiring applications. Revisions to the *NEC* between the 2014 and 2017 editions are carefully identified.
- **Review Questions** at the end of each chapter allow readers to test what they have learned in each chapter and to target any sections that require further review.

New to This Edition

Every *Code* reference in the sixteenth edition of *Electrical Wiring—Commercial* is the result of comparing each and every past *Code* reference with the 2017 *NEC*. As always, the authors review all comments submitted by instructors from across the country, making corrections and additions to the text as suggested. The input from current users of the text ensures that what is covered is what electricians need to know.

- Emphasis is given to making the wiring of the Commercial Building conform to energy saving Standards. In other words, the wiring and connected loads in *Electrical Wiring—Commercial* are “Green.”
- Text and a figure were added about the requirement that the short-circuit current be marked at the service equipment, the calculation documented and distributed. The value in the marking must be updated if this value changes due to modifications.
- *Article 100*: Definitions of “Readily Accessible” and “Structure” were revised.
- *110.14(D)*: The use of a calibrated torque measuring device is required for tightening wire terminals.
- *210.8*: Direction is provided for measuring the distance from a sink for GFCI protection.
- *210.8(B)(9)*: GFCI protection required in non-dwelling crawl spaces.

- *210.71*: Receptacle requirements added for meeting rooms.
- *225.27*: Sealing requirements for raceways that enter a building.
- *250.66(A), (B), and (C)*: clarification of connection to grounding electrodes.
- *250.122(F)*: Rules for equipment grounding conductors in parallel significantly revised.
- *310.15(B)(3)(c)*: derating for raceways on rooftops significantly revised.
- *314.15*: sizing of weep holes revised.
- *406.15*: rules on dimmer-controlled receptacles removed.
- *440.9*: equipment grounding conductor required in some raceways installed on rooftops for HVAC equipment.
- *445.20*: requirements for receptacles on portable receptacles revised.
- Extensive changes were made to *Article 690* for photovoltaic systems. The chapter in this text was revised to update these requirements.
- Revisions were made to the branch circuit tables and load calculation tables for consistency.
- Major revisions of many diagrams and figures have been made to improve the clarity and ease of understanding the *Code* requirements.
- All *National Electrical Code* references have been updated to the 2017 *NEC*. Changes between the 2014 and 2017 editions of the *NEC* are marked with these symbols: ▶◀

Supplement Package

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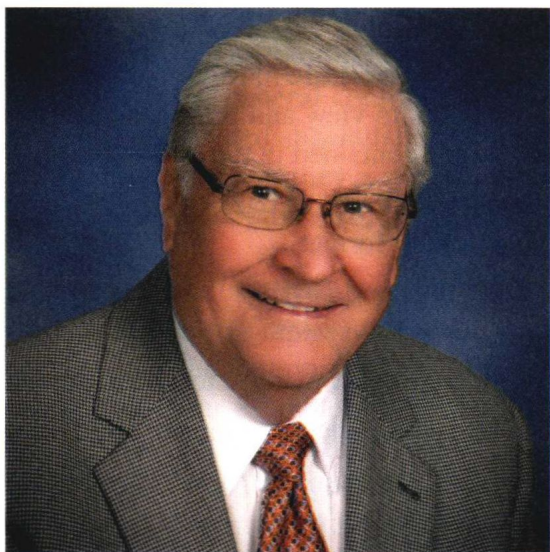
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- **Measure Skills and Outcomes**: Analytics and reports provide a snapshot of class progress, time on task, engagement, and completion rates.

About the Authors

This text was prepared by Ray C. Mullin and Phil Simmons.



Mr. Mullin is a former electrical circuit instructor for the Electrical Trades, Wisconsin Schools of Vocational, Technical and Adult Education. A former member of the International Brotherhood of Electrical Workers, Mr. Mullin is presently an honorary member of the International Association of Electrical Inspectors, an honorary member of the Institute of Electrical and Electronic Engineers, and an honorary member of the National Fire Protection Association, Electrical Section. He served on Code Making Panel 4 for the *National Electrical Code*, NFPA-70 for the National Fire Protection Association.

Mr. Mullin completed his apprenticeship training and has worked as a journeyman and supervisor. He has taught both day and night electrical apprentice and journeyman courses and has conducted engineering seminars. Mr. Mullin has contributed to and assisted other authors in their writing of texts and articles relating to overcurrent protection and conductor withstand ratings. He has had many articles relating to overcurrent protection published in various trade magazines.

Mr. Mullin attended the University of Wisconsin, Colorado State University, and Milwaukee School of Engineering.

He served on the Executive Board of the Western Section, International Association of Electrical Inspectors. He also served on their National Electrical Code Committee and on their Code Clearing Committee. He is past chairman of the Electrical Commission in his hometown.

Mr. Mullin has conducted many technical Code workshops and seminars at state chapter and section meetings of the International Association of Electrical Inspectors and served on their Code panels.

Mr. Mullin is past Director, Technical Liaison, and Code Coordinator for a large electrical manufacturer and contributed to their technical publications.



Phil Simmons is self-employed as Simmons Electrical Services. Services provided include consulting on the *National Electrical Code* and other Codes, writing, editing, illustrating, and producing technical publications and inspection of complex electrical installations. He develops training programs related to electrical codes and safety and has been a presenter on these subjects at numerous seminars and conferences for Universities, the NFPA, IAEI, Department of Defense, and private clients. Phil also has provided plan review of electrical construction documents. He has consulted on several lawsuits concerning electrical shocks, burn injuries, and electrocutions.

Mr. Simmons is the co-author and illustrator of *Electrical Wiring—Residential* (17th through this edition) and *Electrical Wiring—Commercial* (14th through this edition) and author and illustrator

of *Electrical Grounding and Bonding*, all published by Cengage Learning. While at the International Association of Electrical Inspectors (IAEI), Phil was author and illustrator of several books, including the *Soares Book on Grounding of Electrical Systems* (five editions), *Analysis of the NEC* (three editions), and *Electrical Systems in One- and Two-Family Dwellings* (three editions). Phil wrote and illustrated the National Electrical Installation Standard (NEIS) on *Standard on Types AC and MC Cables* for the National Electrical Contractors Association.

Phil presently serves NFPA on Code Making Panel-5 of the *National Electrical Code* Committee (grounding and bonding). He previously served on the *NEC CMP-1* (*Articles 90, 100, and 110*), as Chair of *CMP-19* (articles on agricultural buildings and mobile and manufactured buildings), and member of *CMP-17* (health care facilities). He served six years on the NFPA Standards Council, as NFPA Electrical Section President and on the *NEC Technical Correlating Committee*.

Phil began his electrical career in a light-industrial plant. He is a master electrician and was owner and manager of Simmons Electric Inc., an electrical contracting company. He is also a licensed journeyman electrician in Montana. Phil passed the certification examinations for Electrical Inspector General, Electrical Plan Review, and Electrical Inspector One- and Two-Family.

He previously served as Chief Electrical Inspector for the State of Washington from 1984 to 1990 as well as an Electrical Inspector Supervisor,

Electrical Plans Examiner and field Electrical Inspector. While employed with the State, Phil performed plan review and inspection of health care facilities including hospitals, nursing homes, and boarding homes.

Phil served the IAEI as Executive Director from 1990 to 1995 and as Education, Codes, and Standards Coordinator from 1995 through June 1999. He was International President in 1987 and has served on several local and regional committees.

He served Underwriters Laboratories as a Corporate Member and on the Electrical Council from 1985 to 2000 and served on the UL Board of Directors from 1991 to 1995. Phil is a retired member of the International Brotherhood of Electrical Workers.

Important Note

Every effort has been made to be certain that this book is technically correct, but there is always the possibility of typographical errors.

If changes in the *NEC* do occur after the printing of this text, these changes will be incorporated in the next printing.

The National Fire Protection Association has a standard procedure to introduce changes between *NEC Code* cycles after the actual *NEC* is printed. These are called “Tentative Interim Amendments,” or TIAs. TIAs and a list of errata items can be downloaded from the NFPA website, <http://www.nfpa.org>, to make your copy of the *Code* current.



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The authors gratefully acknowledge the contribution of the chapter on Commercial Utility Interactive Photovoltaic Systems by Pete Jackson, electrical inspector for the City of Bakersfield, CA.

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