10th EDITION

Save Time ► Save Money ► Take Anywhere

**EXPANDED AND UPDATED EDITION**
for the 2023 National Electrical Code® and
the 2024 International Residential Code®

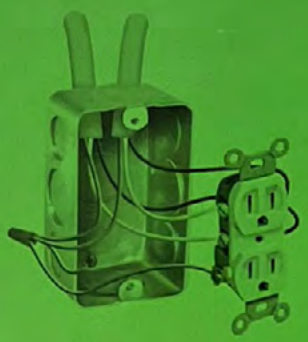
# Code Check®

# Electrical

An Illustrated Guide to Wiring a Single-Family Home

- Services
- Grounding
- Panels
- AFCIs & GFCIs
- Branch Circuits
- Lighting
- Boxes
- Appliances
- Cables
- Conduits
- Photovoltaics
- Pools & Spas

Sample Pages





ICC
INTERNATIONAL CODE COUNCIL®

# Code ☑ Check® Electrical 10th Edition



**Based on the 2023 National Electrical Code® and 2024 International Residential Code® including annotated changes from the previous code editions**

**BY DOUGLAS HANSEN, REDWOOD KARDON, SKIP WALKER & GLENN MATHEWSON**

Illustrations by Paddy Morrissey & Douglas Hansen
©2025 by the authors ISBN 978-1-4197-9162-8 Printed in China

## INTRODUCTION & EXAMPLES

***Code Check Electrical for the 2023 NEC*** is based primarily on the ***2023 National Electrical Code (NEC®)*** and the ***2024 International Residential Code (IRC®)***. Changes from previous code editions are highlighted throughout the text and summarized at the bottom of each page. If an item is not shown as a change, then the code line also applies for the 2020 NEC or 2021 IRC.

This book includes multifamily and light commercial electrical installations. It does not cover installations over 1,000 volts, legally required emergency and standby systems, fire alarms, supervised industrial installations, hazardous locations, health care facilities, marinas, and many other specialized items covered by the codes.

The National Fire Protection Association (NFPA®) produces the electrical portion of the IRC using material extracted from the N
are relevant to new 1- & 2-family dwellin
does not include several topics that mig
temporary wiring, and photovoltaic sys
item, we provide both code citations. T
commercial installations, as those are b

The information in this book is believe
informational purposes only and is no
the referenced codes. It should not b
for the enforceable interpretation of t

***Conventions used in this book:*** T
headings, subheadings, and "checkbox
condense such a large amount of inform
abbreviations, as seen on the page belo

**The inside cover lists the codes and standards that are used in the book, along with examples of the shorthand conventions that are used.**

When only one code is referenced, the subheading will end with the abbreviation for that code, as at the bottom of this page, where the items are found in the 2024 IRC. When two codes are referenced, they are listed as seen at the top of the right column on this page, which shows the 2024 IRC and the 2023 NEC.

Figures and tables are referenced in the text by the prefix **F** or **T** in bold and color, as in the 5th checkbox line in the right column, where **F1** references figure 1, NRTL labels.

Code changes from the previous edition are highlighted by a different color in the code reference, as in the 5th checkbox line in the right column of this page. There is also a superscript number after the code citation, and that number refers to a footnote at the bottom of the page. This example also shows how abbreviations are used, such as "L&L" which is explained in the table of abbreviations and acronyms on page 1. Further, this example also shows where the glossary that starts on ***p.52*** is helpful, as it explains the word "identified" that is the subject of that particular code change.

Exceptions to a particular code are shown by using the abbreviation EXC at the end of the line, with the exception on the following line. Here is an example from ***p.26***:

| | 24 IRC | 23 NEC |
|---|---|---|
| ☐ Permitted as EGC EXC | 3908.9 | 358.60 |
| • Wire-type EGC in EMT outdoors to rooftop AC equipment | n/a | 440.9 |

*This line, under the subheading of Electrical Metallic Tubing (EMT) is saying that EMT is permitted as an equipment grounding conductor (EGC) except when run outdoors to rooftop air-conditioning equipment, where a wire-type EGC is required. Note also that this exception is not found in the IRC, where it is shown as "n/a."*

## GENERAL RULES

| Permits | 24 IRC |
|---|---|
| ☐ Construction, alteration, relocation, or repair of electrical equipment requires permit EXC | 105.1 |
| • Listed cord-&-plug-connected temporary decorative lighting | 105.2 |
| • Re-installation of receptacles, but not the outlets therefor | 105.2 |
| • Replacement of branch circuit OCPDs in same location | 105.2 |
| • Wiring, devices & appliances less than 25V & less than 50W | 105.2 |
| • Minor repairs (lamp replacement) or connection of portable equipment | 105.2 |

| Inspection & Approval of Equipment | 24 IRC | 23 NEC |
|---|---|---|
| ☐ Code is intended for application by local AHJ | 104.1 | 90.4A |
| ☐ Materials, components & equipment must be approved | 104.9 | 110.2 |
| ☐ AHJ may approve modifications for individual cases | 104.2.3 | 90.4C |
| ☐ AHJ may waive code requirements for materials that are not yet available at time of adoption of code | 104.2.3 | 90.4D |
| ☐ Equipment that is listed, labeled, L&L, **F1** or identified for a use must be installed & used in accordance w/ instructions in the listing, labeling, or identification | 104.2.1 & 3403.3[1] | 110.3B[1] |

### Nationally Recognized Testing Laboratories (NRTLs)

*Listing & labeling is performed by qualified Nationally Recognized Testing Laboratories (NRTLs) **F1**. The Occupational Safety and Health Administration (OSHA) establishes qualifications for NRTLs. Standards for equipment are ons such as NEMA, NFPA, UL Solutions, tronics Engineers, Inc. (IEEE). The most s. Their standards are available (read-only egistration is required for viewing.*

**Labels**

**r a product ssified for a plication:**

*f a classified d be a circuit breaker suitable for another manufacturer's panel.*

*"CERTIFIED." Smart markings include a QR code.*

**Marking of a component within a listed product:**

*An example of a registered component could be a pump motor within a listed spa. The individual component is not listed other than as part of the listed spa.*

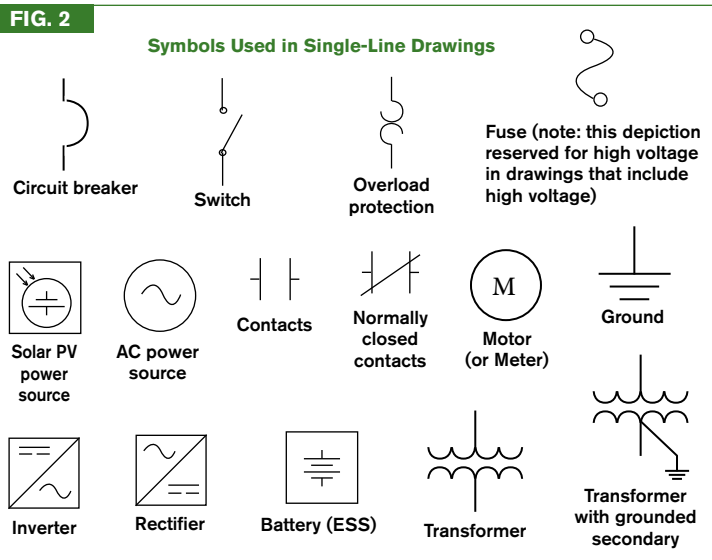
*Equipment that is altered, reconditioned, or field-assembled may have a field evaluation performed by an independent agency approved by the local jurisdiction.*

**Other NRTL logos:**

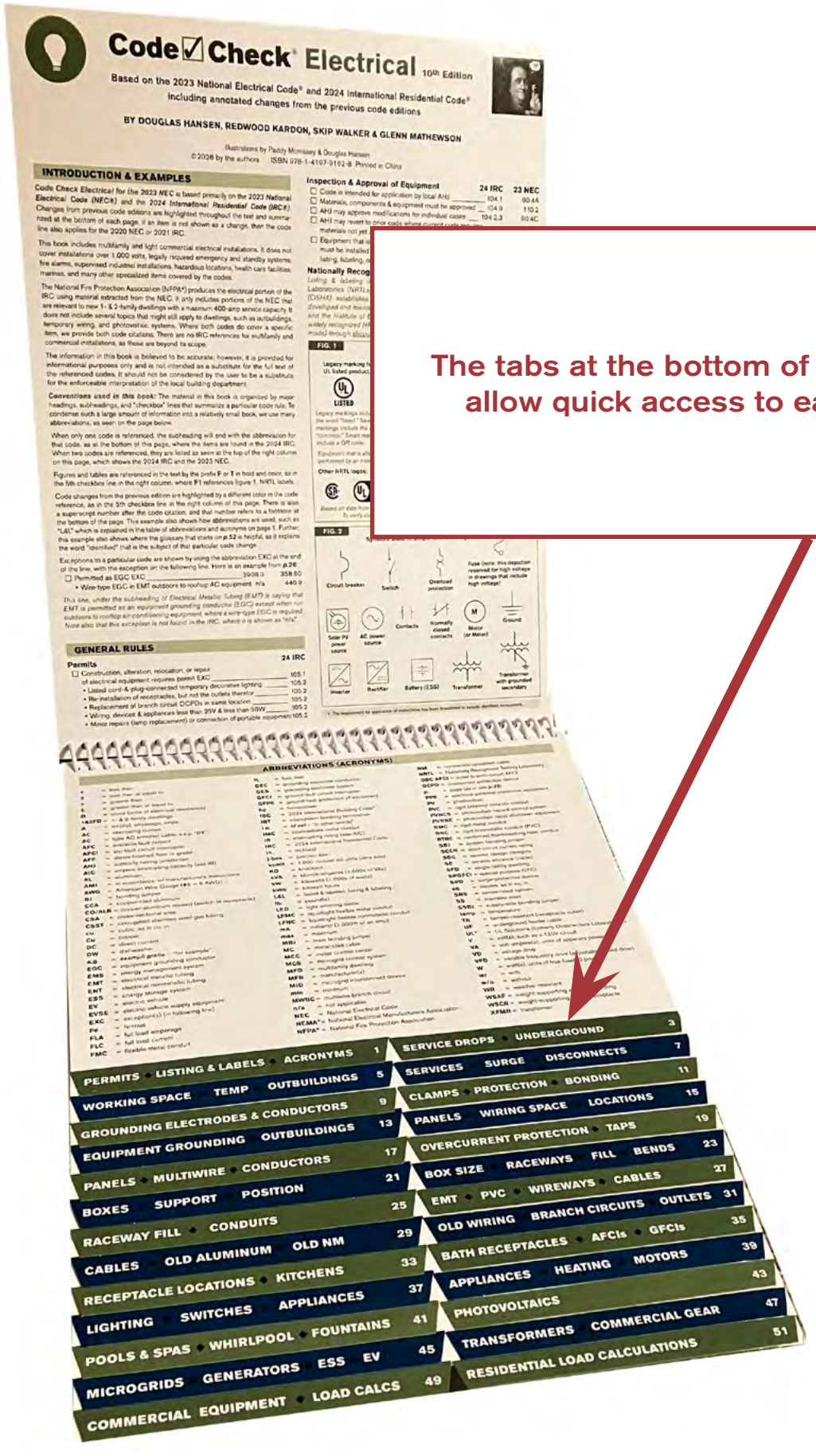
*Based on data from the Occupational Safety and Health Administration June 19, 2025. To verify current status and see complete list, visit the OSHA website.*

**FIG. 2**

**Symbols Used in Single-Line Drawings**




1. The requirement for application of instructions has been broadened to include identified components.




The tabs at the bottom of every page allow quick access to each topic

| Bathroom Receptacles F60 | 24 IRC | 23 NEC |
|---|---|---|
| ☐ Min 1 20A circuit for required bath receptacles EXC | 3703.4 | 210.11C3 |
| • Other outlets OK if serving only 1 bathroom | 3703.4X | 210.11C3X |
| • Additional 15A or 20A circuits may serve receptacles other than required receptacles serving the countertop area | 3703.4 | 210.11C3 |
| ☐ Required within 3 ft. of each basin, located in wall or on cabinet not more than 12 in. below top of basin or countertop | 3901.6 | 210.52D |
| ☐ No face-up receptacles on vanity countertop EXC | 4002.16 | 406.5G1 |
| • Listed countertop-mounted receptacles | 4002.15 | 210.52D |
| ☐ Not in tub or shower or in zone extending 3 ft. horizontally & 8 ft. vertically above top of tub rim or shower threshold, and not outside tub below this zone EXC | 4002.11 | 406.9C |
| • In dwelling-unit bathrooms too small to comply, install opposite tub or shower on farthest wall within the room | 4002.11X | 406.9CX2 |
| • Space separated by floor, wall, ceiling, room door, or fixed barrier (such as shower glass) | 4002.11[64] | 406.9C[64] |
| • Hydromassage tub receptacle outlets | 4002.11X[64] | 406.9CX1[64] |
| • Listed WSCR | 4002.11X[64] | 406.9CX3[64] |
| • Receptacle for personal hygiene device if installed outside the space between a toilet and the tub or shower | 4002.11X[64] | 406.9CX4[64] |

## ARC-FAULT CIRCUIT INTERRUPTERS (AFCIS)

| Means of Providing AFCI Protection | 24 IRC | 23 NEC |
|---|---|---|
| ☐ AFCIs must be readily accessible | 3902.20 | 210.12 |
| ☐ Combination-type AFCI at origin of branch circuit | 3902.21(1) | 210.12A1 |
| ☐ Branch/feeder-type AFCI breaker & OBC type at first outlet box on circuit, w/ outlet box marked as first on circuit | 3902.21(2) | 210.12A2 |
| ☐ Ordinary OCPD supplying metal raceway or cables to first outlet, w/ OBC AFCI at first outlet | 3902.21(5) | 210.12A5 |
| ☐ Ordinary OCPD supplying conduit, tubing, or MC encased in min 2-in. concrete to first outlet & OBC AFCI at first outlet | 3902.21(6) | 210.12A6 |

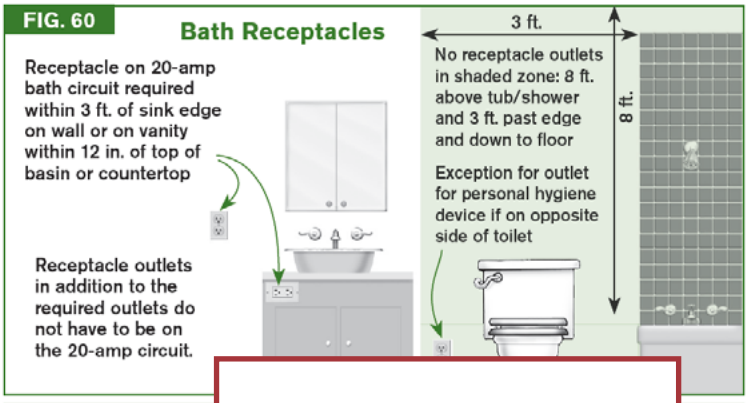
| Locations Requiring AFCI Protection | | |
|---|---|---|
| ☐ Applies to 10, 15 & 20A branch circuits | 3902.21[65] | 210.12B[65] |
| ☐ Dwelling-unit kitchens, family rooms, dining & living rooms, parlors, libraries, dens, bedrooms, sunrooms, recreation rooms, closets, hallways, laundry areas, or similar areas EXC | 3902.21 | 210.12B |
| • An individual branch circuit installed with a metal-clad wiring method for an Article 760 fire alarm system | 3902.21X | 210.12BX1 |
| • An individual branch circuit for arc-welding equipment | n/a | 210.12BX2 |
| ☐ Dormitory-unit bedrooms, living rooms, hallways, closets, bathrooms & similar rooms | n/a | 210.12C |
| ☐ Guest rooms & suites of hotels & motels, patient sleeping rooms in nursing homes & limited-care facilities, and areas used exclusively as sleeping quarters in fire/police stations and similar | n/a | 210.12D |

| Extensions, Modifications, and Replacements | | |
|---|---|---|
| ☐ If branch-circuit wiring extended, modified, or replaced in areas where AFCI protection currently required, either AFCI at origin of branch circuit or OBC AFCI at first outlet of existing branch circuit EXC | 3902.22 | 210.12E |
| • If extension of conductors ≤6 ft. & does not include added outlets or devices other than splices; 6-ft. measurement does not include conductors inside enclosures or boxes | 3902.22X | 210.12EX |

*This exception addresses a situation where a distribution panel is converted to a junction box, with its original branch-circuit wiring extended to a new panel within 6 ft. of the original one.*

| | | |
|---|---|---|
| ☐ If located where AFCI protection would currently be required, replacement receptacles require AFCI by OBC outlet, or upstream OBC AFCI, or from combination-type AFCI breaker | n/a | 406.4D4 |

**FIG. 60 Bath Receptacles**




## GFCIs

| General | | NEC |
|---|---|---|
| ☐ GFCIs to be listed | | 210.8[66] |
| ☐ GFCI devices to b | | 210.8 |
| ☐ Readily accessible | | ch |
| circuit in lieu of pro | | 215.9 |
| ☐ Distance from rece | | |
| cord w/out piercing | | 210.8 |

| Dwelling-Unit Rec | | |
|---|---|---|
| ☐ Applicable to recep | | 210.8A |
| ☐ Bathrooms | | 10.8A1 |
| ☐ Garages & | | 10.8A2 |
| ☐ Outdoors | | 10.8A3 |
| ☐ Crawlspaces at or | | 10.8A4 |
| ☐ Basements | | 10.8A5 |
| ☐ All receptacles in k | | .8A6[67] |
| ☐ Areas w/ sinks & p | | .8A7[68] |
| ☐ Within 6 ft. of top | | 10.8A8 |
| ☐ Within 6 ft. of outside edge of bathtubs or shower stalls | 3902.9 | 210.8A10 |
| ☐ Laundry areas (including clothes dryers) | 3902.10 | 210.8A11 |
| ☐ Indoor damp or wet locations (e.g., mud rooms) | 3902.11 | 210.8A12 |
| ☐ Receptacles required for servicing equipment (e.g., in attic within 25 ft. of attic furnace) | 3902.13 | 210.8E |
| ☐ Receptacles in boathouses | 3902.15 | 210.8A9 |

| Exceptions to GFCI Protection for Dwelling Receptacles | | |
|---|---|---|
| ☐ Not-readily accessible receptacles supplied by a circuit dedicated to snow-melting, deicing, or pipeline heating OK to have GFPE protection at trip setting AMI per 426.28 or 427.22 | 3902.18[69] | 210.8X1[69] |
| ☐ Receptacles for permanently installed premises security system (fire or burglar alarm) | 3902.18[70] | 210.8X2[70] |
| ☐ Listed weight-supporting ceiling receptacles (WSCR) for ceiling luminaires or ceiling-suspended paddle fans | 3902.18[71] | 210.8X3[71] |
| ☐ Receptacles that are not readily accessible & mounted internally to bathroom fan exhaust assemblies | 3902.1[72] | 210.8X4[72] |

**Code changes from the previous edition are highlighted in the text. A summary explanation of them is included in the footnotes at the bottom of the page.**

64. The intent of this rule is to prevent the use of cord-&-plug-connected appliances inside a tub or shower. The change extends the zone outside the tub or shower down to the floor. An exception was added for barriers such as fixed shower glass. The exception for hydromassage tubs clarifies what was otherwise a contradiction with 680.73. The receptacle for a personal hygiene device (previously allowed in below the tub rim) is now allowed only on the opposite side of the toilet from the tub.
65. 10A circuits added to this list.
66. Clarification that the term GFCI is for protection of personnel, and that these devices be listed as such. The terminology in previous code editions was inconsistent.
67. Expanded to include all kitchen receptacles, not just those serving countertops or near sinks.
68. New requirement for other areas of food preparation with sinks, including butler's pantries and wet bars.
69. Exception previously applied only to exterior receptacles for snow-melting or deicing.
70. Exception previously applied only to basement receptacles for this purpose.
71. Exception previously only applied to a specific list of locations for such devices. If the connected luminaire includes a general-purpose receptacle, GFCI protection is required.
72. Clarification that the "receptacle" that is internal to a bathroom exhaust fan is exempt unless required by the installation instructions or listing of the fan.

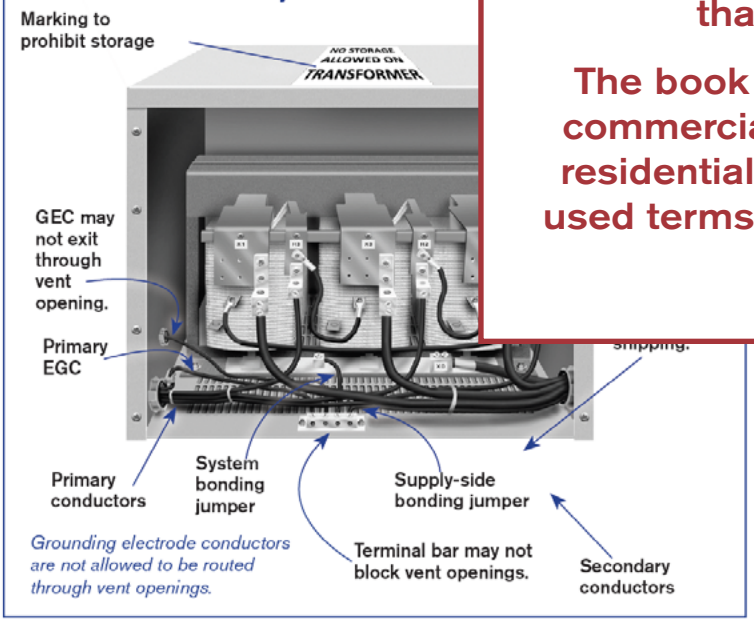
## SEPARATELY DERIVED SYSTEMS—TRANSFORMERS

A separately derived system is a source of voltage, other than a service, that has no direct connection of circuit conductors to any other electrical source, other than by grounding & bonding connections. Generators can be separately derived systems if their transfer switch also switches the neutral conductor. Other than autotransformers, all transformers are separately derived systems in that there is no direct electrical connection between the primary and secondary conductors.

### Required Markings — 23 NEC

- ☐ Nameplate marking must include the MFR, rated kVA, frequency, primary & secondary voltage, impedance (for XF
- vent opening clearances, and the temperature cl
- ☐ Install marking to prohibit storage on top of XFM
- readily accessible & have horizontal top surfaces
- ☐ When disconnecting means in remote location, c
- means lockable & location durably marked on XF

**FIG. 81** Delta-Wye Transformer




### Locations — 23 NEC

- ☐ XFMRs to be readily accessible to qualified personnel EXC _____ 450.13
  - • Dry-type XFMRs ≤1kV OK in the open on walls or columns _____ 450.13A
  - • Dry-type XFMRs ≤1kV & ≤ 50kVA w/ sufficient ventilation for cooling OK in hollow spaces of structure (e.g., above suspended ceiling) if not permanently closed in by structure _____ 450.13B
- ☐ Room or area ventilation must be sufficient to dissipate XFMR heat w/o ambient temp rise exceeding XFMR rating _____ 450.9
- ☐ Install so ventilation openings not blocked—clearances AMI _____ 450.9
- ☐ Indoor XFMRs ≤112½ kVA require 12-in. clearance to combustible material unless completely enclosed except ventilation openings (typical of most XFMRs) _____ 450.21A
- ☐ Indoor XFMRs >112½ kVA require room w/ min 1-hr. fire rating unless completely enclosed except ventilation openings & Class 155 or higher insulation (typical of most XFMRs) _____ 450.21B
- ☐ Outdoor XFMRs >112½ kVA require min 12 in. from combustible material unless completely enclosed except ventilation openings & Class 155 or higher insulation (typical of most XFMRs) _____ 450.21B
- ☐ Outdoor XFMRs require weatherproof enclosure _____ 450.22

### Disconnecting Means

- ☐ Specific circuit source marked on XFMR disconnecting means _____ 110.22
- ☐ Disconnect within sight or in remote location EXC _____ 450.14
  - • Not required for Class 2 or Class 3 transformers _____ 450.14
- ☐ When disconnecting means in remote location, disconnecting means lockable & location durably marked on XFMR _____ 450.14
- ☐ Transformers OK to be operated in parallel if switched as a unit _____ 450.7

### Overcurrent Protection of Transformer (under 1kV) — 23 NEC

- ☐ Primary-only protection allowed only for single-phase XFMR w/ 2-wire secondary or 3-phase delta-delta XFMR _____ 240.21C1
- ☐ Primary-only protection max 125% of XFMR rating _____ T450.3B
- ☐ Primary & secondary protection: primary max 250% of XFMR rating, secondary max 125% of XFMR rating _____ T450.3B

*In practical terms, protecting the conductors as required in other sections of the code will also protect the transformer.*

### Overcurrent Protection of Secondary Conductors

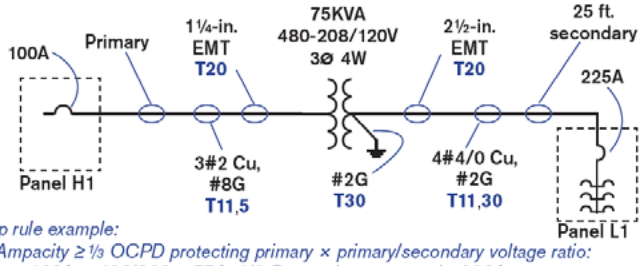
_____ 240.21C2
at termination
y supply

dary voltage ratio
_____ 240.21C6
y voltage ratio
nductor ampacity
pproved means
r in industrial installations
(raceway), secondary
e systems ___ 240.21C3
itation if: _____ 240.21C4

tor ampacity
eans
entrance of conductors
ase XFMR w/ 2-wire
ndary conductor
ry OCPD ___ 240.21C1

for OCPD that protects secondary conductors _____ 240.21C

**FIG. 82** Transformer Single-Line Example




*25-ft. tap rule example:*
*1. Ampacity ≥ ⅓ OCPD protecting primary × primary/secondary voltage ratio:*
*✓⅓ × 100A × 480/208 = 77A, 4/0 Cu conductor ampacity 230A.*
*2. Conductors terminate in single OCPD ≤ than conductor ampacity.*
*✓ 225A breaker ≤ 230A*
*3. Conductors enclosed in raceway.*
*✓ 2½-in. EMT*

**TABLE 29 TRANSFORMER FULL-LOAD CURRENTS**

| Single-Phase | | | | 3-Phase | | | | |
|---|---|---|---|---|---|---|---|---|
| kVA | Amps | | | kVA | Amps | | | |
| | 120V | 240V | 480V | | 208V | 240V | 480V | 600V |
| 3 | 25 | 12.5 | 6.1 | 15 | 41.6 | 36 | 18 | 14.4 |
| 5 | 41 | 21 | 10.4 | 30 | 83.0 | 72 | 36 | 28.8 |
| 7.5 | 62 | 31 | 15.6 | 45 | 125 | 108 | 54 | 43 |
| 10 | 83 | 42 | 21 | 75 | 208 | 180 | 90 | 72 |
| 15 | 124 | 62 | 31 | 112.5 | 312 | 270 | 135 | 108 |
| 25 | 208 | 104 | 52 | 150 | 415 | 360 | 180 | 144 |
| 37.5 | 312 | 156 | 78 | 200 | 554 | 480 | 240 | 192 |
| 50 | 416 | 208 | 104 | 225 | 625 | 540 | 270 | 216 |
| 75 | 624 | 312 | 156 | 300 | 830 | 720 | 360 | 288 |
| 100 | 830 | 415 | 207 | 400 | 1110 | 960 | 480 | 384 |
| 167 | 1390 | 695 | 348 | 500 | 1380 | 1200 | 600 | 480 |
| 200 | 1660 | 833 | 416 | 750 | 2080 | 1800 | 900 | 720 |

**The print edition has 86 illustrations and 40 tables. These are referenced in the text along with the code number that applies to them.**

**The book contains information on commercial installations as well as residential. A glossary of frequently used terms is at the end of the book.**