Code Check® Electrical 7th Edition

Based on the 2014 & 2011 NEC® and the 2012 IRC®

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Code Check Electrical 7th Edition is a field guide to common code issues in residential electrical installations. It is based on the ***2014 National Electrical Code (NEC)*** with cross references to the ***2011 NEC*** and the ***2012 International Residential Code (IRC).*** Before beginning any electrical project, check with your local building department to determine the code edition used in your area. In addition to a model code, energy codes and utility rules may also apply.

Where there is no IRC column in the book, the topic might not be addressed by the IRC. That is the case for older wiring methods and for photovoltaics. The IRC states that items not specifically mentioned in it must comply with the NEC, even when the local jurisdiction has adopted the IRC. This applies to issues such as old wiring, outside feeders, and photovoltaics, which are not covered in the IRC.

For further information, articles by the Code Check team and why Ben Franklin is featured in the book visit: ***www.codecheck.com***

HOW TO USE CODE CHECK ELECTRICAL

Basic Conventions:

Most lines in ***Code Check Electrical*** provide two code references. The first is the 2012 IRC reference, and the second is the 2014 NEC reference. Unless the 2014 NEC reference is highlighted as a change, the same rule applied in the 2011 NEC. The following example is from **p.3**:

☐ Max 6 disconnects to shut off power_____ [3601.7] {230.71}

This line states that there can be no more than 6 disconnects to shut off the power, and the rule is found in 3601.7 of the IRC and 230.71 of the NEC.

An "EXC" at the end of a line means that an exception–or exceptions–to the rule will follow in the next line, as in this example from **p.9**:

☐ Size per service conductor size **T6** EXC _____ [3603.4] {250.66}
• 6 AWG Cu largest size needed if ending at rod_____[T3603.1] {250.66A}

This states that the grounding electrode conductor (GEC) size is based on the size of the service conductors, in accordance with Table 6, except that the portion of the GEC that solely serves a ground rod need never be larger than 6 AWG.

Text lines ending in OR mean that an alternative rule follows in the next line, as in this example from **p.18**:

☐ Separate 20A circuit for bath receptacles only OR_____ [3703.4] {210.11C3}
• Dedicated 20A circuit to each bathroom _____ [3703.4X] {210.11C3X}

A separate 20-amp circuit must be supplied for no other purpose than the bathroom receptacles. Alternatively, each bathroom can be supplied with its own 20-amp circuit, and then other outlets in that bathroom (such as lights) could be on the circuit.

Code Changes & Using this Book with Older Codes:

Significant changes are highlighted by having their code number in a different color, and the code number has a superscript reference to the table on **p.31**. By looking for these differently colored code ciations, you can quickly tell is an item applied in the 2008 NEC, or if it was new in the 2011 NEC, or if it was new in the 2014 NEC.

If there is no code change in either the 2012 IRC column or the 2014 NEC column, then that particular item also applied in the 2008 NEC. If there is a change in only the 2014 NEC column, then the item did not apply in the 2011 NEC. The following example is from **p.18**:

☐ Min one receptacle each car space _____ [n/a] {210.52G1}[37]

This change is a rule that a garage have a minimum of one receptacle outlet per car space. It is a new rule in the 2014 NEC, and does not apply to the 2012 IRC or the 2011 NEC. This change is item 37 in the table on the inside back cover.

Because the 2012 IRC electrical section is based on the 2011 NEC, changes in the 2011 NEC can also be determined from this book, as in this example from from **p.12:**

☐ Feed-through conductors OK to pass through panel if warning label applied that identifies power source__ [3907.1][13] {312.8}

This change requires a warning label when conductors from one panel pass through another panel. The means of disconnecting the circuit must be identified. It was new in the 2011 NEC, and is change number 13 in the table on the inside back cover.

ABBREVIATIONS

A = amp(s), amperage, amps
AC = air conditioning
AC = alternating current
AC = armored cable, a.k.a. "BX"
AFCI = arc-fault circuit interrupter
AHJ = Authority Having Jurisdiction
Al = aluminum
AMI = in accordance with manufacturer's instructions
AWG = American Wire Gauge
CO = carbon monoxide
COM = communication wire
cu. = cubic, as in cu. in.
Cu = copper
DC = direct current
EGC = equipment grounding conductor
EMT = electrical metallic tubing
ENT = electrical nonmetallic tubing, a.k.a. "Smurf tubing"
EV = electric vehicle
EXC = exception(s)
FMC = flexible metal conduit
ft. = foot, feet
GEC = grounding electrode conductor
GES = grounding electrode system
GFCI = ground-fault circuit interrupter
GFPE = ground-fault protection of equipment
hp = horsepower
IMC = intermediate metal conduit
in. = inch(es)
IRC = International Residential Code
kcmil = 1,000 circular mil units (conductor size – formerly MCM)
L&L = listed & labeled, listing & labeling
lb. = pound(s)
LFMC = liquidtight flexible metal conduit
LFNC = liquidtight flexible nonmetallic conduit
manu = manufacturer(s)
max = maximum
MC = metal-clad cable
min = minimum
n/a = minimum
NEC = National Electrical Code
NFPA = National Fire Protection Association
NM = nonmetallic-sheathed (cable)
OBC AFCI = Outlet Branch Circuit AFCI
OCPD = overcurrent protection device (breaker or fuse)
PV = photovoltaic
PVC = rigid polyvinyl chloride conduit
req = require, requiring, requirement
req'd = required
req's = requires
RMC = rigid metal conduit
SCCR = short circuit current rating
SE = service entrance cable
SFD = single-family dwelling
sq. = square, as in sq. in.
temp = temperature
UF = underground feeder cable
USE = underground service entrance cable
TR = tamper-resistant
V = volt(s), such as a 120V circuit
VA = volt-ampere(s), units of apparent power
W = watt(s), units of true (useful) power
WR = weather-resistant

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GLOSSARY

Accessible: Not permanently concealed or enclosed by building construction. A piece of equipment can be considered accessible even if tools must be used or other equipment must be removed to gain access to it.

Accessible, readily: Capable of being reached quickly for operation or inspection without actions such as the use of tools or ladders or the need to remove obstacles.[1] *(This is the first code change, described on* ***p. 31)***

Approved: Acceptable to the authority having jurisdiction (AHJ). The AHJ will usually approve materials that are listed and labeled.

Arc-fault: An electric current propagated through air.

Arc-Fault Circuit Interrupter (AFCI): A device intended to provide fire protection by recognizing arc characteristics and de-energizing the circuit when they are detected.

Authority Having Jurisdiction (AHJ): The building official or persons authorized to act on his or her behalf.

Bonded, bonding: Connected to establish continuity and conductivity.

Branch circuit: The circuit conductors between the final overcurrent protection device (OCPD) (breaker or fuse) protecting the circuit and the outlet or outlets.

- **Branch circuit, general purpose:** Branch circuit that supplies 2 or more receptacles or outlets for lighting and appliances.
- **Branch circuit, individual:** Branch circuit supplying only 1 piece of equipment.
- **Branch circuit, multiwire, residential:** Branch circuit consisting of 2 hot conductors having 240V potential between them and a grounded neutral having 120V potential to each hot conductor **F18.**
- **Branch circuit, small appliance:** Branch circuit supplying portable household appliances in kitchens and related rooms.

Device: A piece of equipment that carries or controls electrical energy as its primary function, such as a switch, receptacle, or circuit breaker.

Equipment grounding conductor (EGC): A wire or conductive path that limits voltage on metal surfaces and provides a path for fault currents **F10**.

Feeders: Conductors supplying panelboards other than service panels.

Flexibility after installation: Anticipated movement after initial installation, such as that caused by motor vibration or equipment repositioning.

Ground: The earth.

Ground fault: An unintentional connection of a current-carrying conductor to equipment, earth, or conductors that are not normally intended to carry current.

Ground-Fault Circuit Interrupter (GFCI): A device to protect against shock hazards by interrupting current when an imbalance of 6 milliamps or more is detected.

Grounded conductor: A current-carrying conductor that is intentionally connected to earth (a neutral).

Grounding electrode conductor (GEC): A conductor used to connect the service neutral or the equipment to a grounding electrode or to a point on the grounding electrode system **F5–9** .

Interrupting rating: The highest current a breaker or fuse can interrupt without sustaining damage.

Luminaire (formerly lighting fixture): A complete lighting unit including parts to connect it to the power supply, and possibly parts to protect or distribute the light source. A lampholder, such as a porcelain socket, is not itself a luminaire.

Neutral conductor: The conductor connected to the neutral point of a system and that is intended to carry current under normal conditions **F15–16.**

Outlet: The point on a wiring system at which current is taken to supply equipment. A receptacle or a box for a luminaire (fixture) is an outlet; a switch is not an outlet.

Overcurrent: Any current in excess of the rating of equipment or conductor insulation. Overcurrents are produced by overloads, ground faults, or short circuits.

Overfusing: A fuse or breaker that has an overload rating greater than allowed for the conductor it is protecting.

Overload: Equipment drawing current in excess of the equipment or conductor rating and in such a manner that damage would occur if it continued for a sufficient length of time. Short circuits and ground faults are not overloads.

Service: The conductors and equipment providing a connection to the utility **F1,F15**.

Service drop: The overhead conductors supplied by the utility **F1**.

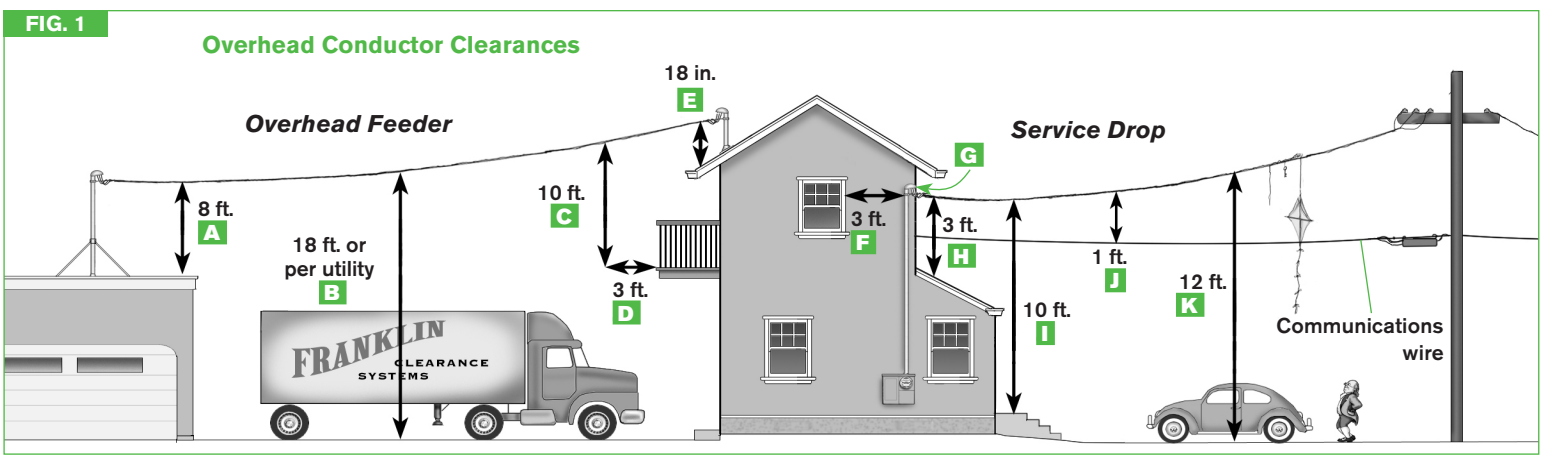
Service equipment: The equipment at which the power conductors entering the building can be switched off to disconnect the premises' wiring from the utility power source. A meter can be a part of or separate from the service equipment.

Service lateral: Underground conductors from the utility to the service point **F3**.

.**Short circuit:** A direct connection of current-carrying conductors without the interposition of a load, resulting in high levels of current.

Short Circuit Current Rating (SCCR): The amount of current that panelboards and switchboards must be able to carry during a short circuit condition without sustaining damage. See *"Interrupting rating."*

FIG. 1



OVERHEAD SERVICE DROP CLEARANCES

Service drop conductors typically have no outer jacket for physical protection and no overload protection at their source. They are protected by isolation. The serving utility may have different rules that override the clearance specifications in the code. Check with your local jurisdiction to determine any variations from the standard clearances below. The clearances here also apply to overhead feeders.

Vertical above Roof F1	**12 IRC**	**14 NEC**
☐ <4-in-12 slope: min 8 ft. A EXC	[3604.2.1]	{230.24A}
• 3 ft. OK if roof area guarded or isolated	[3604.2.1X5][2]	{230.24AX5}
☐ ≥ 4-in-12 slope: min 3 ft. H EXC	[3604.2.1X2]	{230.24AX2}
• 18 in. OK for ≤4 ft. over eaves E	[3604.2.1X3]	{230.24AX3}
☐ Maintain req'd distance for 3 ft. past roof edge EXC	[3604.2.1]	{230.24A}
• Edge clearance above roof is not req'd where overhead conductors attach to side of building G	[3604.2.1X4]	{230.24AX4}

Vertical above Grade F1	**12 IRC**	**14 NEC**
☐ 10 ft. above final grade to lowest point of drip loop	[3604.2.2]	{230.24B1}
☐ Area accessible only to pedestrians: 10 ft. I	[3604.2.2]	{230.24B1}
☐ General above grade & driveways: 12 ft. K	[3604.2.2]	{230.24B2}
☐ Above roads or parking areas subject to truck traffic: 18 ft. B	[3604.2.2]	{230.24B4}
☐ Any direction from swimming pool water: 22½ ft.	[4203.6]	{680.8A}

Openings & Communication Wires F2	**12 IRC**	**14 NEC**
☐ Vertical above decks & balconies: 10 ft. C	[n/a]	{230.9B}
☐ From side of area above decks & balconies: 3 ft. D	[3604.1]	{230.9A}
☐ Below or to sides of openable window: 3 ft. F	[3604.1]	{230.9A}
☐ Communications wire min 12 in. to parallel power wires J	[n/a]	{800.44A4}

The clearances from windows & doors apply to open conductors & not to conductors contained inside a raceway or a cable with an overall outer jacket. The codes do not have a requirement for min. clearance of open conductors above a window. Check to see if your local utility has a requirement.

FIG. 17 **Wire Bending Space**

(For clarity, neutrals & EGCs not shown)

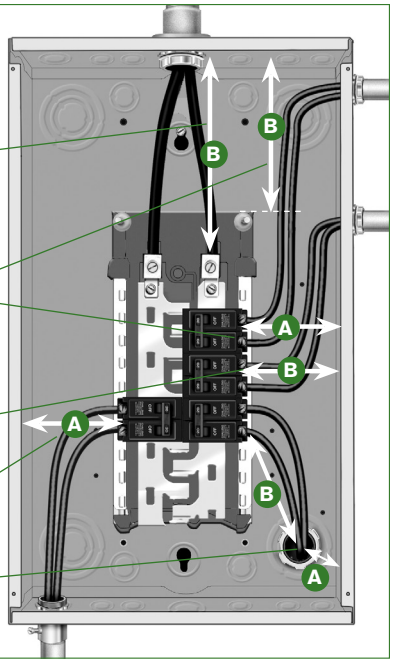


TABLE 8 **MINIMUM WIRING SPACE OPPOSITE TERMINALS**

L Bends – Wire not through wall opposite terminal (A)		S Bends – Wire enters or leaves (B) enclosure in wall opposite terminal		
Wire Size (AWG or kcmil)	Required Space (in.)[1]	Cu Wire Size (AWG)	Compact Al (AWG or kcmil)[2]	Required Space (in.)[3]
14 – 10	n/a	14 – 10	12 – 8	n/a
8 – 6	1½	8	6	1½
4 – 3	2	6	4	2
2	2½	4	2	3
1	3	3	1	3
1/0 – 2/0	3½	2	1/0	3½
3/0 – 4/0	4	1	2/0	4½
250	4½	1/0	3/0	5½
300 – 350	5	2/0	4/0	6
400 – 500	6	3/0	250	6½
600 – 700	8	4/0	300	7

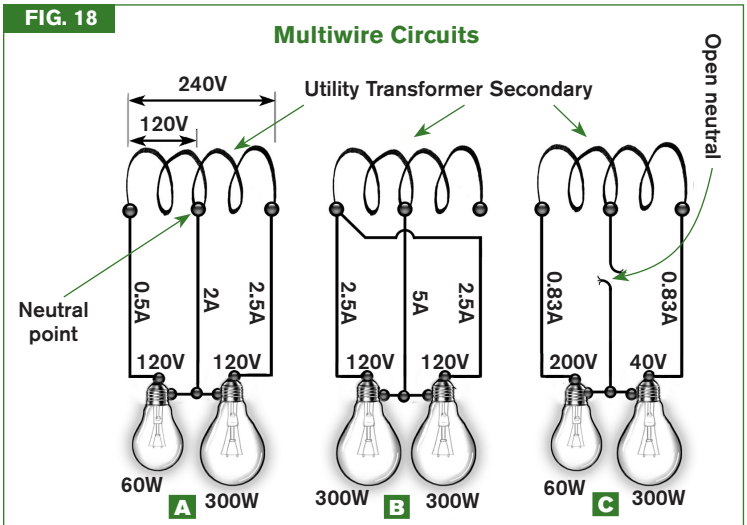
1. When a lug lies at an angle, the distance can be measured along the length of the wire in the direction that the wire leaves the terminal.
2. Compact stranded aluminum conductors do not have as much interstitial space as copper conductors and therefore the table allows slightly larger sizes for these when making an "S" bend.
3. The distance is measured in a straight line from the lug in a direction perpendicular to the panel wall.

Multiwire Circuits

	12 IRC	14 NEC
☐ Hot conductors must originate from opposite poles	[3501]	{100}
☐ All conductors must originate from same panel	[3701.5]	{210.4A}
☐ Multiwire neutrals may not feed through devices such as receptacles (pigtail lead from neutral to splice in box)	[3406.10.2]	{300.13B}
☐ All multiwire circuits req handle tie or single handle	[3701.5.1]	{210.4B}
☐ All conductors of multiwire circuit must be grouped (wire ties or other means) inside panel EXC **F16**	[3701.5.2]	{210.4D}
• Cable systems where grouping is obvious **F16**	[3701.5.2X]	{210.4DX}
• Where conductors have numbered wire markers corresponding to their circuit numbers	[n/a]	{210.4DX}[15]

Standard electrical services to 1- and 2-family dwellings originate at a utility transformer with two ungrounded "hot" conductors and a neutral derived from the center of the transformer's secondary coil, as depicted in **F18**. The neutral is connected to earth and is referred to as the "grounded" conductor. The neutral limits the voltage on either of the hot conductors to 120V to ground. Not only is the service to the house a "3-wire" circuit, but 120V branch circuits are often installed with shared neutrals, and are then known as multiwire circuits. If the neutral is broken or loose, voltages become erratic, as in **F18** **C**. TV sets, motors, and computers don't do well with fluctuating voltages. Signs of unstable voltage, such as incandescent bulbs growing brighter or dimmer as other loads change, could indicate a loose neutral either at a branch circuit or at the utility.

FIG. 18 **Multiwire Circuits**



A **PROPER CIRCUIT** 2 unequal loads are fed by a 3-wire circuit. The neutral carries the imbalance between the 2 loads.

B **OVERLOADED NEUTRAL** Without voltage potential between the hot conductors, the neutral carries the sum of the loads. In a 3-conductor NM cable, the black & red wires must originate from different poles.

C **OPEN NEUTRAL** Two unequal loads in series across 240V from the transformer. The load with lowest resistance sees the lower voltage. Voltage at each load depends on other loads and is unstable.

BRANCH CIRCUITS & OUTLETS (CONTINUED)

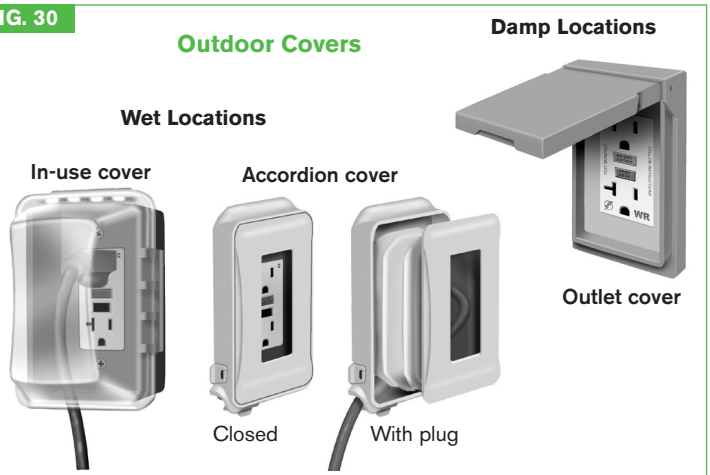
Bathrooms (see p. 15 for GFCI req's)	12 IRC	14 NEC
☐ Receptacle req'd on wall or partition within 3 ft. of each basin or in side or face of cabinet ≤ 12 in. below top of basin	[3901.6]	{210.52D}[34]
☐ No face-up receptacle outlets on vanity countertop	[3901.6]	{406.5E}
☐ Listed countertop-mounted receptacles OK	[3901.6][35]	{210.52D}
☐ No receptacles within or directly over tub or shower	[4002.11]	{406.9C}
☐ Separate 20A circuit for bath receptacles only OR	[3703.4]	{210.11C3}
• Dedicated 20A circuit to each bathroom	[3703.4X]	{210.11C3X}
☐ Max rating of fixed space heater on general lighting circuit 15A circuit: 900W; 20A circuit: 1,200W	[3702.5]	{210.23A2}

Laundry (see p. 15 for GFCI req's)	12 IRC	14 NEC
☐ Min 1 20A circuit for laundry receptacles	[3703.3]	{210.11C2}
☐ No other outlets on laundry receptacle circuit	[3703.3]	{210.11C2}
☐ Receptacle within 6 ft. of intended appliance location	[3901.5]	{210.50C}
☐ Electric dryer min 30A circuit	[T3704.2(1)]	{220.54}
☐ Electric dryer req's 4-conductor branch circuit EXC	[3908.7]	{250.140}
• Existing 3-wire circuits allowed to remain in use	[n/a]	{250.140X}

Outdoors (see p. 15 for GFCI req's)	12 IRC	14 NEC
☐ Receptacle readily accessible from grade req'd at front & rear of dwelling max 6½ ft. above grade	[3901.7]	{210.52E1}
☐ Receptacle max 6½ ft. above walking surface req'd at attached decks & balconies w/ interior access	[3901.7][36]	{210.52E3}
☐ 15A & 20A nonlocking receptacles in damp or wet locations req'd to be listed weather-resistant type	[4002.8]	{406.9A&B}
☐ Receptacles in outdoor damp location (e.g., protected porch) req weatherproof cover	[4002.8]	{406.8A}
☐ Wet location 15A & 20A receptacles req in-use covers **F30**	[4002.9]	{406.8B1}

Garages & Basements (see p. 15 for GFCI req's)	12 IRC	14 NEC
☐ Garages req min one receptacle	[3901.9]	{210.52G1}
☐ Min one receptacle each car space	[n/a]	{210.52G1}[37]
☐ No outlets outside garage on same circuit as garage	[n/a]	{210.52G1}[38]
☐ Min one receptacle each accessory building w/ power	[3901.9]	{210.52G2}
☐ Min one receptacle each unfinished basement area	[3901.9]	{210.52G3}

FIG. 30



BOXES

Boxes must be large enough to prevent crushing & overheating of wire and devices. Wires must be long enough so splices & connections can be worked on clear of the box opening. Luminaires that are supported from boxes are generally designed for connections inside the box, rather than inside the luminaire canopy. Device boxes are threaded for 6–32 screws used to mount switches and receptacles. Lighting outlet boxes provide 8–32 (for luminaires) or 10–24 screws (for listed paddle fan boxes).

General	12 IRC	14 NEC
☐ Boxes req'd for each outlet, splice or pull point EXC	[3905.1]	{300.15}
• Integral enclosures, wireways, & gutters	[3905.1.3]	{300.15A&E}
☐ Metal boxes must be grounded	[3905.2]	{314.4}
☐ Box & conduit body covers must remain accessible	[3905.11]	{314.29}
☐ Boxes must be closed w/cover, faceplate, or luminaire	[3906.9]	{314.25}
☐ Cover must be attached w/ machine screws that match thread gauge integral to box	[n/a]	{314.25}[39]
☐ Wet location boxes req listing for wet locations	[3905.12]	{314.15}
☐ Damp or wet location boxes must keep out water	[3905.12]	{314.15}
☐ OK to drill ¼ in. drainage holes in wet location boxes	[n/a]	{314.15}[40]

Position in Walls & Ceilings	12 IRC	14 NEC
☐ Max ¼ in. setback from noncombustible surface **F33**	[3906.5]	{314.20}
☐ Boxes flush or projecting if combustible surface **F33**	[3906.5]	{314.20}
Note: the IRC req's boxes flush or projecting, not set back, in wood-frame walls.		
☐ Listed box extenders OK to correct excess setback	[3906.5]	{314.20}
☐ Plaster gap max ⅛ in. for flush cover boxes **F33**	[3906.6]	{314.21}

Support & Rating	12 IRC	14 NEC
☐ Boxes must be supported	[3906.8]	{314.23}
☐ PVC & EMT not OK for box support	[3906.8.5]	{314.23E&F}
☐ PVC & EMT OK for conduit body support	[3906.8.5]	{314.23E&F}
☐ Luminaires only in boxes designed for luminaires EXC	[3905.6]	{314.27A}
• Wall sconces ≤ 6 lb. on device boxes with 2 #6 screws	[3905.6X]	{314.27A1X}
☐ Ceiling luminaire boxes req 50 lb. rating **F32**	[3905.7]	{314.27A2}
☐ Ceiling luminaires > 50 lb. req independent support	[3905.7]	{314.27A2}
☐ Wall luminaire boxes max weight marked if > 50 lb.	[3905.6]	{314.27A1}
☐ Paddle fans req L&L paddle fan box	[3905.9]	{314.27C}
☐ Ceiling mounted boxes w/ spare separately switched ungrounded conductors req listing for paddle fan	[3905.9]	{314.27C}
☐ Smoke & CO alarms OK to support on device boxes	[3905.9X]	{314.27A1}

FIG. 31

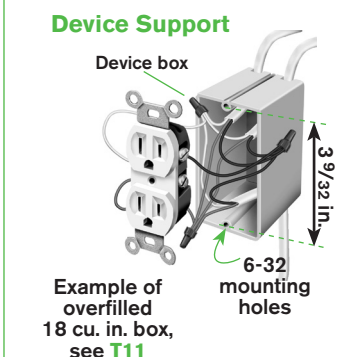
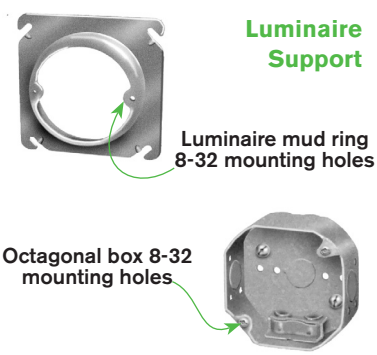


FIG. 32



Paddle fans req. 10-32 screws on L&L fan box.