



Office of Education and Data Management
Fall 2018 Career Development Seminar

December 2018

Residential Electrical Inspections

*Presented by
Michael Ose, BO, E-1, DAS Construction Services Building Official,
Office of State Building Inspector*

Who Are You

- Building Officials, Electricians/ EI, Contractors, Fire Marshals
- Inspectors are responsible for ensuring equipment is installed in accordance with listing instructions/ manufacturer instructions
- Inspectors are to ensure safety of the town structures and the buildings (life safety devices, health and integrity of building)
- Level of consistency depends on experience and training
- Violations are to be cited to the installer in written form with code section noted.

4

Single Family Dwelling



5



New Construction Inspections

230.9 220.40 230.6 New construction
 230.24 230.26 230.54 Single family dwelling
 230.66 230.79 110.26 200a 120/240v overhead utility
 110.14 110.13 250.24 service
 250.92 250.94 250.122 Natural Gas
 250.66 250.50 250.52 City Water City Sewer
 250.53 250.64 408.36 Pretty straight forward, but there
 408.4 408.7 800.100 are many code sections that
 820.100 250.104 250.12 apply.
 Let's start outside.

What's mine is mine, what's yours is yours



Utility determines the Service Point
 Customer owns (NEC covers) house side of service point.
 Utility owns (NEC does not cover) utility side of service point.
 Typically the connection at the weather head is the service point

Service Point



Attachment broken, Lost Neutral



11

Let me be clear...

2017 NEC 230.24

Overhead service conductors

From finish grade: 10' to drip loop

10' over pedestrians

12' over residential property and driveways,

(commercial areas NOT subject to truck traffic)

18' over public street, roads and parking areas
subject to truck traffic, other land such as grazing, orchards, and forest
(NEW 2017) 24 1/2' over railroad tracks

12

Code Check Electrical

230.9 Clearances of Open
Conductors:

Above Decks: 10'

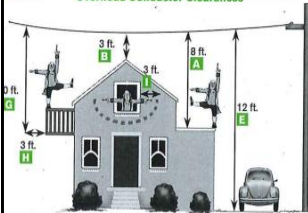
Operable Windows,
Porches, Stairs, Doors: 3'

230.24

Over Flat Roof: 8'

Over Steep Roof: 3'

FIG. 1 Overhead Conductor Clearances



13



Can't Touch This...



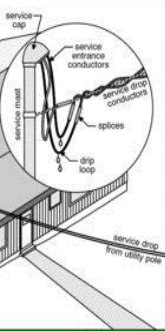
14

Drip Loop

Service drop

the service drop is the wires running from the utility pole to the point of connection to the house these are sometimes referred to as overhead wires or overhead service

the service drop terminates at the drip loop an underground service has buried service laterals running from the utility to the service entrance conductors



230.54 A and B (E3605.9.1 and .2)
Service Cap
Service Head
Weather Head

230.54 F (E3605.9.5)
Drip Loops
Individual conductors stripped from cable

15

Any Violations?



230.9 A 3' under window

230.54 C weather head to be above point of attachment

Meter socket at 5'?

Service drop over roof?

Are those taped up *couple taps*?

18



230.24 Exception 3 min 18" (E3604.2.1)



20

Point of Attachment (E3604.3)



21

Mast Support



22



Mast Service



23

Guy Wire Support

Outside the building, 230.6 (5) passing through an eave

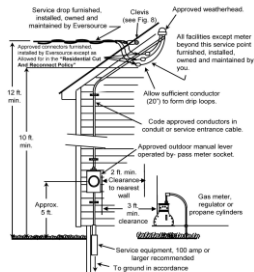


230.28 A (E3604.5.1) Service Mast support. Guy wire opposite pull of conductors.

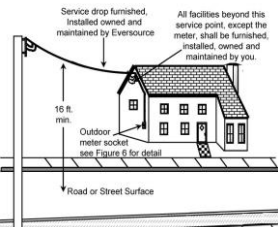
24

Eversource I&R Guide

Overhead Service Entrance Facilities



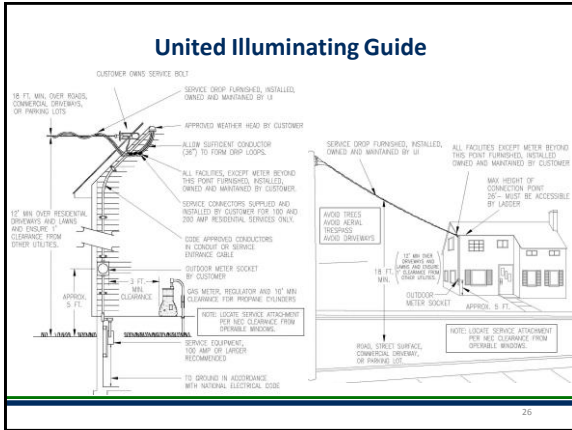
Overhead Service



Note:
A. Electrical contractor must mark stud location for Eversource service wire holder.
B. For service attachment points exceeding 20 ft. in height contact us.

25






Eversource vs UI

Drip Loop Conductors	20"	36"
Meter from Gas Meter	3'	3'
Meter from Regulator	3'	3'
Meter from Propane Tank	3'	10'
Meter from Wall	2'	?
Meter Height	5'	5'

Service Entrance Conductors




Service Cable Support

230.51 (E3605.7)
 12" from weather head
 30" strap to strap
 12" from meter
 12" from enter house

230.54 C (E3605.9.3)
Service head shall be located ABOVE the point of attachment.
 Exception: impracticable; within 24"



SE Cable



338.10 A SE Cable as Service Entrance Conductors

338.10 B Feeder – old method of wiring stove, dryer, wall oven (see 250.140 commentary)

338.24 Bends, 5 x diameter

338.120 Marking IAW 310.120 Cable assembly, **not individual conductors stripped out.**

29

Size does matter

230.42 (E3602.1) Service entrance conductors shall have ampacity of not less than the maximum load to be served.

310.15 B (7) (1)
Service conductors supplying entire load of SFD, ampacity of conductors to be 83% of service rating.


200 amp x 83% = 166 amp

Table 310.15 B (16) 75 degree column (due to terminal lug rating)
4/0 Aluminum = 180 amp

What about 100 amp service? 400 amp service?
Size printed on cable assembly or individual conductors 310.120

30

Duct Seal Putty



230.54 G
Arranged so that water will not enter service raceway or equipment.

230.66
Suitable for use as service equipment (bonding, fault current, bypass handle)
Listed for voltage and amperage of service

230.79
120/240v minimum 100amp
200amp, 320amp
Nice strap within 12"
Screws for application-coated

31

Meter



- Approved, listed in I&R book.
- Height 5' center.
- Line on top, Load on bottom.
- Proper screws to house. 110.13
- Bond to frame jumper 250.92
- Anti-oxidant on lugs(trade practice)
- Same size wire in and out, stripped back so wire is under lug.
- Terminals torqued.
- Watertight, sealed.
- Connector out bottom or out back to panel.

32

Meter Enclosure bonding jumper



33

Listed Meter Socket



34

Or a Meter with Main outside



35

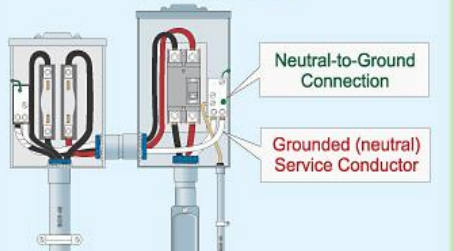
Main Service Disconnect Bonding



36

Neutral Bonded to Meter Can

Bonding Service Equipment to Grounded Conductor
Section 250.92(B)(1)



37

Service Raceways and Enclosures must be Bonded

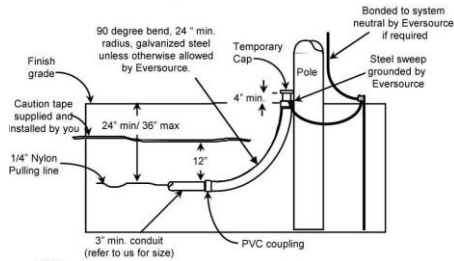


250.80 Metal Enclosures (meter sockets, cold sequence meter disconnects, fire pump disconnect, troughs, nipples) and metal raceways, containing service conductors, MUST be bonded to the Service Neutral conductor.

Any metal installed AHEAD of the Main breaker.

38

Underground Steel 90 at pole



Note:

1. Provide suitable backfill (no rocks)
2. All conduit shall be inspected by the local municipal authority prior to backfilling.
3. Electric service sweeps shall be located on the pole side away from oncoming traffic.

39

Metal Sweep and Expansion Coupling



40

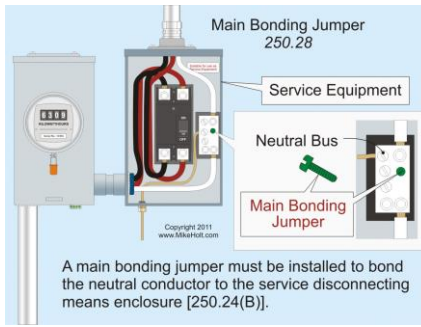


The Green Screw



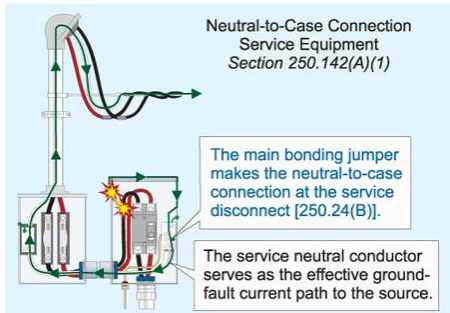
41

Grounds and Neutrals Bonded at Main



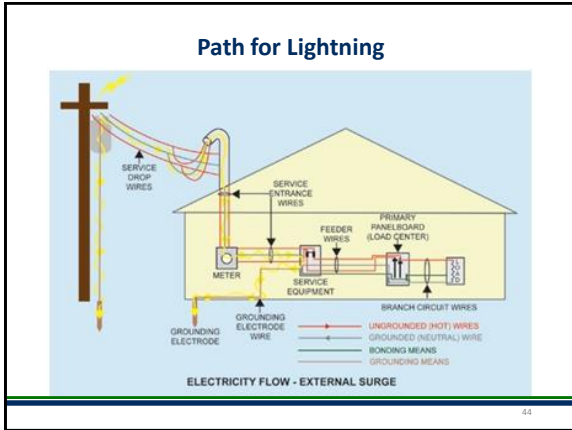
42

Service Fault Current Path



43





Service Panel (first means of disconnect)

Main breaker, first means of disconnect, grounds and neutrals bonded together (and never again!) 250.24 (except on the 3 wire stove and dryer you still have 250.104).

230.70 A 1 "The service disconnecting means (main) shall be installed at a readily accessible location either outside of the building or structure, OR, inside nearest the point of entrance of the service conductors."

A: Outside of the building or structure
 B: Inside nearest the point of entrance of the service conductors

230.6 "outside" is outside, not inside. 5 other conditions considered "outside".

45

Oh By the way...

250.140 Exception (3)

" the grounded conductor is uninsulated and part of a Type SE service entrance cable and branch circuit originates at the service equipment."

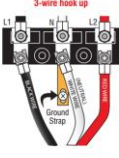
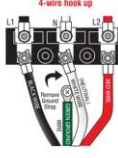


If a transfer switch is installed, that is Main disconnect rated, the original "Main" Panel is now a sub panel. Fed with a 4 wire, separate grounds and neutrals. That old 3 wire, flat SEU that feeds the stove and the dryer...needs to be changed to 4 wire.

"Fed from main service panel" which now is the transfer switch Main.

46





250.140

<p>Older Homes and Electric Ranges</p> 	<p>Newer Homes and Electric Ranges</p> 
	

47

Breaker Breaker



How many breakers can be in a panel?

How many “mini’s”?

How many circuits is the panel listed to supply? 408.54

48

Some Ground Rules
Grounding vs Bonding

Grounding is Bonding
Bonding is not Grounding

Bonding – connecting together to establish electrical continuity and conductivity
Grounding – connecting to ground (the earth)

Grounding – green or bare
Grounded – dead- white or gray

49



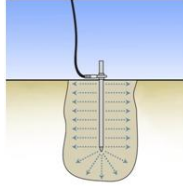
Grounding Electrode Function

Connects the electrical System to the earth

Connects electrical Equipment to the earth

Dissipate overvoltage into the earth:

- Lightning
- High volt wire to low volt wire
- Transformer fault



50

250.52 Grounding Electrode

- A 1 **Underground Metal Water Pipe** * 10' of pipe in **direct** contact with earth *
- A 2 **Metal In-Ground (earth) Support Structure** (new 2017) piles 10' vertical
- A 3 **Concrete Encased Electrode (Ufer)**- 20' - 1/2" rebar continuous OR #4 bare copper in 2" of concrete in footing or foundation in **direct** contact with earth (no vapor). (Building official to verify and tag?)
- A 4 **Ground Ring Electrode**- encircle building 30" deep, min 20' #2 bare copper
- A 5 **Rod and Pipe Electrode** * 5/8" x 8' , 45°, in ditch 30" deep *
- A 6 **Listed Electrode**
- A 7 **Plate Electrode** * 1ft x 1ft = 2ft² (two sides exposed to soil 30" deep) 250.53 H *
- A 8 **Metal Underground System** well casing, tanks

51

CT Amendment

(Amd) **250.50 Grounding Electrode System.** If available on the premises at each *building* or structure served, each item in 250.52 (A)(1) to (A)(7), inclusive, shall be bonded together to form the grounding electrode system. Where none of these grounding electrodes are available, one or more of the grounding electrodes specified in 250.52 (A)(4) to (A)(8), inclusive, *shall* be installed and used.

52



250.52 Grounding Electrode

- A 1 Underground Metal Water Pipe** * 10' of pipe in **direct** contact with earth *
- A 2 Metal In-Ground (earth) Support Structure** (new 2017) piles 10' vertical
- A 3 Concrete Encased Electrode** (Ufer)- 20'- ½" rebar continuous OR #4 bare copper in 2" of concrete in footing or foundation in **direct** contact with earth (no vapor)
- A 4 Ground Ring Electrode**- encircle building 30" deep, min 20' #2 bare copper
- A 5 Rod and Pipe Electrode** * 5/8" x 8' , 45°, in ditch 30" deep *, or pipe ¾" x 8' galvanized
- A 6 Listed Electrode**
- A 7 Plate Electrode** * 1ft x 1ft = 2ft² (two sides exposed to soil 30" deep) 250.53 H *
- A 8 Metal Underground System** well casing, tanks

53

Grounding Electrode Conductor

- | | |
|---|---|
| <p>100 Amp Service
#6 to Water Main
#8 to Rods</p> <p>200 Amp Service
#4 to Water Main
#6 to Rods</p> <p>Subject to physical
damage</p> | <p>250.66 Size of Grounding (green or bare) Conductor</p> <p>250.68 Termination to Grounding Electrode
A. Accessible (except buried)
B. Effective Grounding Path - bond around insulated joints and parts to be removed.
C. GEC connection – 1) water-5' from point of entry 2) metal frame 3) rebar type</p> <p>250.70 GEC Termination Fittings - LISTED</p> |
|---|---|

54

Water Line as Grounding Electrode

Jump the Meter to Bond water system



55

Well, Well, Well



A metal well casing is an underground metal structure and is permitted to be used as a grounding electrode. The water piping might be plastic, but the well casing is usually steel, threaded together, and is driven more than 10' into the earth.

Bonus: the metal casing is NOT a water pipe, therefore does not need to be supplemented with rods!
250.52 A (8).

GEC is sized IAW 250.66

56

I Got Nothin'

**"Water pipe is plastic. Too late for Ufer. No building steel.
I got nothin' to ground the service to."**

Soooooolllee Train...

Sole Connection

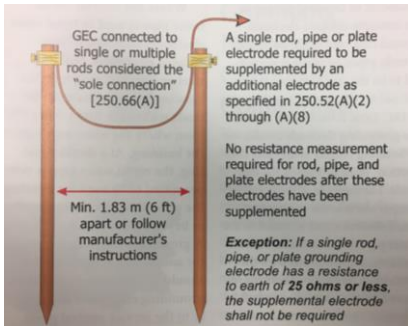
250.66 A GEC no larger than #6 to rod (250.52 A(5))

250.53 A If you drive 1 rod, you must drive another one minimum 6' apart (250.53 B).

Connect with #6 (bonding jumper)

57

Drive One, Drive Two



58



One Piece or Two Piece

“Does the Ground Wire need to be one continuous length from the panel to the rod to the other rod?”

59

One Piece or Two Piece

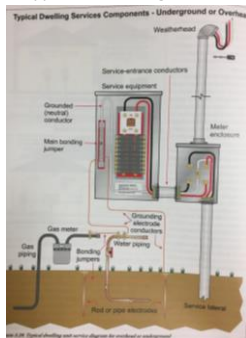
“Does the Ground Wire need to be one continuous length from the panel to the rod to the other rod?”

The “wire” from the panel to the FIRST rod is the Grounding Electrode Conductor. 250.64C states that this must be continuous.

The “other rod” is required by 250.53 A (2) (supplement) The “wire” from rod to rod is a Bonding Jumper (sized by 250.66 A, #6). It does **not** have to be continuous from the panel to rod to rod, 250.53 C (250.64 C is not in the list).

60

Typical Dwelling Service



61



What Am I Looking For?

250.12
Clean Surface/ Contact point Shiny metal, scrape marks,
tapped threads (no TEK screw),
doesn't roll around pipe or rod

110.14 A
Terminals, ONE CONDUCTOR
(more than 1 wire term to be
identified) All strands under lug, strands
not damaged, 1 wire/ lug
good connection without 1 Acorn/ 1 Wire
damaging conductors.

110.14 D (new 2017)
Installation, torquing values. Not loose, can't pull them out

62

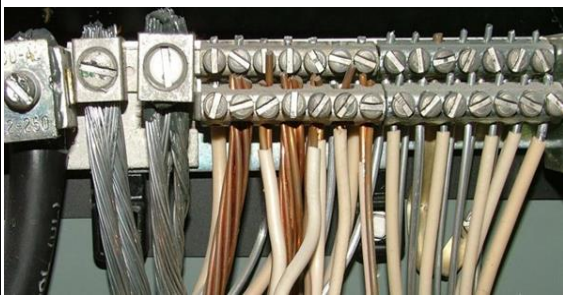
250.68
Terminations to Grounding Electrode must be accessible, buried
full 8' (250.53 G)
Ex 1 buried or concrete

250.70
GEC terminate to GE with listed lugs, listed clamps, listed
pressure connectors (acorns)
How many wires can go under acorn? ONE !!

How many wires can go under a terminal? ONE
(unless listed for more than one)

63

110.14 D Identified for 2 wires



64



110.14 D

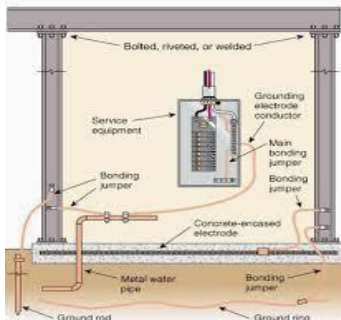


110.14 (A) 2 wires under 1 lug



Bonding Jumpers

E3608 IRC does not include building steel as a grounding electrode. Scope of IRC 3401.2



250.94 Intersystem Bonding



- #6 to terminal
- Bond communication systems
- Accessible
- Required for new services
- Not** required for service changes on existing buildings.

68

250.104 Bonding Other Metal Piping Systems

EGC for circuit that is likely to energize the piping system



69

Bond the Black Iron with #6



70



BREAK

71

Let there be Light



110.26 D
Illumination shall be provided for space around service equipment.

210.70 A (3)
Lighting outlet at or near equipment requiring service.

210.64
1 receptacle (GFCI) installed within 25' of service equipment. (new) Shall be within same room.

72

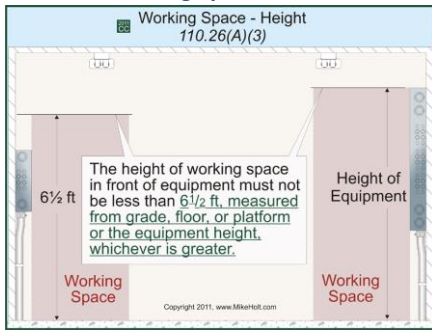
110.26 Working Clearance 30" x 3'



73

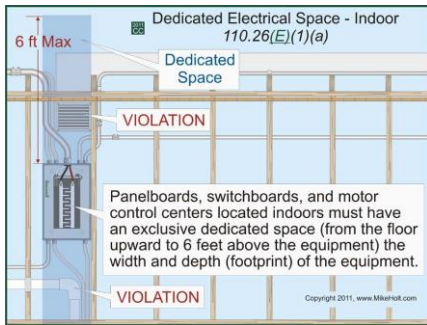


110.26 Working Space 30" x 3' x 6 1/2'



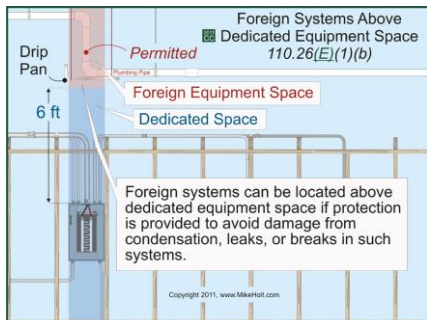
74

110.26 E 1 a Dedicated Space



75

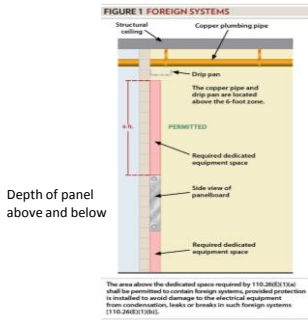
Provide Protection



76



110.26 E 1 b Dedicated space



77

210.11 Branch Circuits Required

220.12 $(3 \text{ volt-amps (watts)} \times \text{square footage}) / 120\text{v} =$
Amps for general purpose lighting

Amps for gen purpose lighting / 15amps = **Number of circuits**

Example:

$3\text{VA} \times 2500 \text{ sqft} = 7500 / 120\text{v} = 62.5\text{amps for gen lighting}$

$62.5 \text{ amps} / 15\text{amps} = 4.16 \text{ lighting circuits}$

Minimum 5 circuits for general lighting

78

210.11 Branch Circuits Required

(C) Dwelling Units. - (1) Small-Appliance Branch Circuits. 2 20 amp small-appliance branch circuits. (normally split by sink, R and L)

(2) Laundry Branch Circuit. 1 20 amp laundry circuit and no other outlets.

(3) Bathroom Branch Circuit. 1 20 amp circuit to supply bathroom receptacle outlets and no other outlets. *Can serve other bathrooms, but nothing else.*

(new 2017) **(4) Garage Branch Circuit.** 1 20 amp circuit (GFCI) to serve garage receptacles. *Can also serve outside receptacles.*

79



220.14 I

How many receptacles per circuit?

180 VA (watts) for each receptacle (single yoke)

20 amps x 120 volt = 2400 VA (watts)

2400 VA / 180 VA = 13.33

13 Receptacles per 20 amp circuit

15amps x 120 volts = 1800 VA (watts)

1800 VA / 180 VA = 10

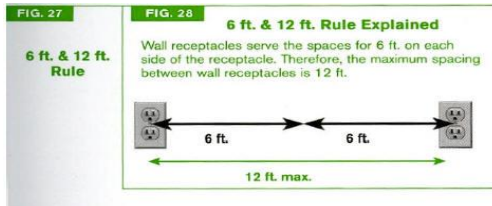
10 Receptacles per 15 amp circuit



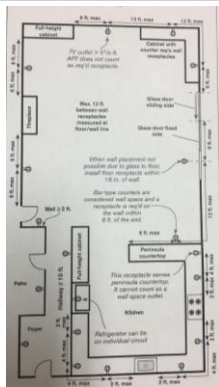
80

210.52 Required receptacles

210.52(A) Proper spacing of receptacle outlets. No point along wall space greater than 6' – any wall space 2' or longer.

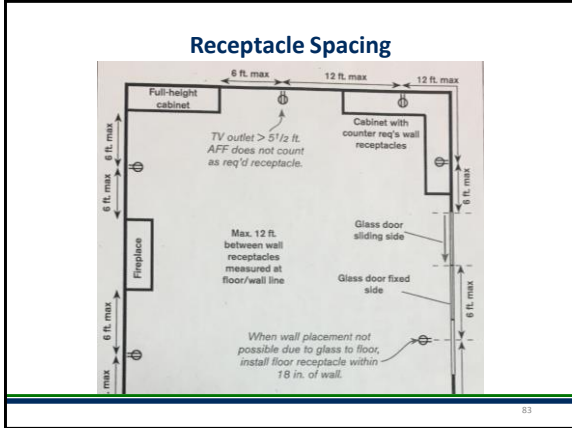


81



82





Kitchen

210.11 C 1
 2 or more 20a small appliance branch circuits, (210.52 B 1) shall serve all wall and floor receptacles covered by 210.52 A, all countertop outlets covered by 210.52 C and receptacle for refrigerator.

That is awful lot to ask 2 circuits to do!

210.52 C Required Receptacles

C (1) Along the wall line wider than 12" – left to right – we know the countertop is 24" deep. C(5) not more than 20" above surface.

Any point along the wall line is no more than 24". Separated by sink, range, refrigerator, wall oven, range top Start measure from sink edge.

C (2) Island – 1 receptacle for each section (perhaps separated by sink or cooktop) that measures 24" x 12"

C (3) Peninsular – measured from connecting wall long 24"x short 12" (E3901.4.3)



FIG. 30 Kitchen Receptacles

Cord-plug connected range-hood allowed if supplied by individual branch circuit.

Max. 12 in. from countertop

Max. 6 in. overhang above receptacle

Island or peninsula countertop spaces req. only 1 receptacle—2 ft./4-ft. rule does not apply.

FIG. 31 2-ft./4-ft. Rule

Wall countertop receptacles serve the spaces for 2 ft. on each side of the receptacle. Therefore, the maximum spacing between receptacles on the same countertop space is 4 ft.

4 ft. max. 2 ft. max. 2 ft. max. 4 ft. max.

4 ft. max.

Receptacle req. when this peninsula dimension is >24 in.

Bar-type counter acts as room divider, so receptacle req. within 6 ft. of end.

This receptacle does not serve the countertop or need GFCI protection.


86

Cut out for cook top. Each side gets 1 receptacle.



87

Peninsular



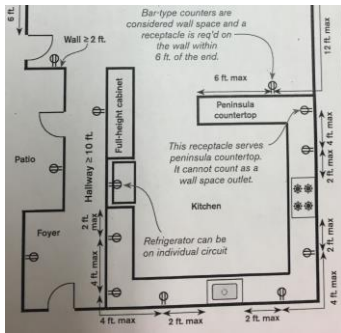
88

Listed Pop up GFCI



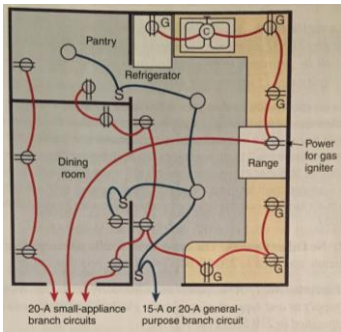
89

Receptacle Spacing



90

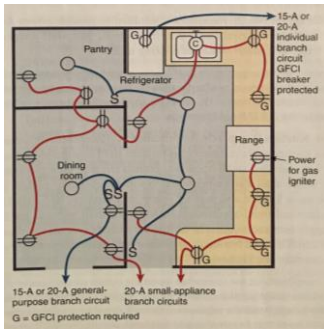
Kitchen circuits



91



Kitchen circuits Exception 2 (2017)



92

Arc Fault Circuit Interrupter



210.12A (E3902.16)
All 15A & 20A, 120V all Branch circuits installed in:
Kitchens
Family rooms
Dining rooms
Living rooms
Parlors, libraries, dens, etc.
Bedrooms
Sunrooms, Rec Rooms
Closets, hallways, etc.
Laundry
All 'similar' areas
NOTE: Some outlets must be both AFCI & GFCI protected

93

Arc Fault

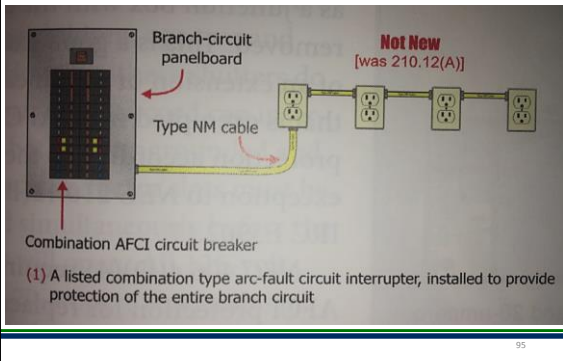
- E3902.16 Arc-Fault Circuit Interrupter
 - 6 Protection Options:
 - 1) Combination AFCI & OCPD Breaker
 - Most common for new installations
 - 2) AFCI Protection at feeder or branch origin
 - Branch circuit protection device at first outlet
 - 3) Supplemental Arc Protection Breaker
 - Arc fault interrupter at first outlet
 - 4) Branch circuit OCPD
 - AFCI Interrupter at first outlet
 - 5) AFCI at first outlet
 - Requires circuit conductor be in metal raceways
 - 6) AFCI at first outlet
 - Requires circuit wires be partially encased in concrete



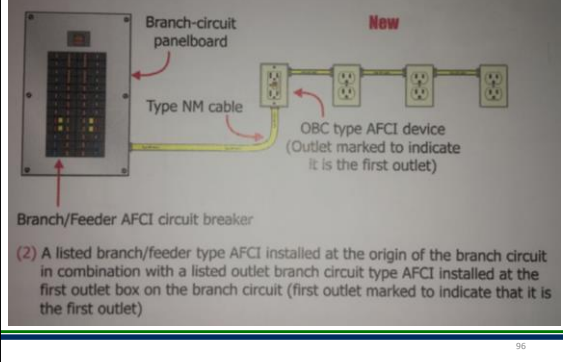
94



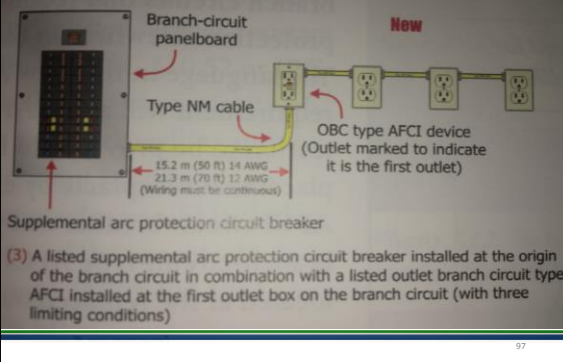
AFCI 1



AFCI 2



AFCI 3





AFCI 4

New

Listed branch circuit OCPD (circuit breaker or fuse)

(4) **System Combination Type AFCI.** A listed outlet branch circuit type AFCI installed at the first outlet in combination with a listed branch circuit over-current protective device (with four limiting conditions) (OCPD & OBC AFCI device must be identified and listed as "System Combination" type AFCI)

98

AFCI 5

Not New
[was 210.12(A) Ex. No. 1]

Listed branch circuit OCPD (circuit breaker or fuse)

(5) A listed outlet branch-circuit type AFCI device (first outlet) is permitted with RMC, IMC, EMT, Type MC, steel armored Type AC cables, metal wireways, or metal auxiliary gutters and metal outlet and junction boxes installed for the portion of the branch circuit between the OCPD and the first outlet

99

AFCI 6

Not New
[was 210.12(A) Ex. No. 2]

Listed branch circuit OCPD (circuit breaker or fuse)

(6) Where a listed metal or nonmetallic conduit or tubing or Type MC cable is encased in not less than 50mm (2 in.) of concrete for the portion of the branch circuit between the OCPD and the first outlet, it shall be permitted to install an a listed outlet branch circuit type AFCI at the first outlet

100



Bathroom

- 210.52 D**
At least 1 15a or 20a 125v receptacle within 3' of EACH basin not below top of basin more than 12"
- 210.8 A 1**
GFCI – all receptacles
- 406.12**
Tamper-Resistant Receptacle
- 210.11 C 3**
At least 1 20a 120v branch circuit for receptacle. Not permitted to serve lighting in bath, but can supply other bathroom receptacles.
- 210.70 A 1**
At least one wall switch. Occupancy sensors allowed (vacancy sensor better?)
- 404.2 C**
Grounded (neutral) conductor to be in switch box

101

20A Bathroom Receptacle Circuit, Dwelling
210.11(C)(3)



102

In Any Room

- | | |
|---|--|
| Proper box for application: fan 3 wire or smoke (422.18) | Any point along the wall to be within 6' of a receptacle. (210.52A) |
| Neutral for occ sensor, identify white as current carrier (200.7) | Switch location (210.70) |
| Draft stopping drilled holes (E3402) | Cables 1 ¼" from edge of framing, thru holes, nail plates, inside corners (300.4) |
| Box fill (314.16) | Support/Staples- 12" from box, 4 ½ ' apart, flat, 1 cable, 2 cables, stackers (334.30) |
| Grounds are made up (250.148, E3908.13) | |

103



Smoke Detectors/CO Detectors 2015 IRC 314

Smokes UL 217

Each story, including basement and habitable attic (story?)

Each sleeping room and adjoining area (hall) 314.3

3' from bath door

3' from vent or paddle fan zone

House power and battery back up 314.6

Interconnected (NEST system OK) 314.4

AFCI

CO

Outside sleeping area 315.3

In bedroom w fuel fired appliance (log) 315.3

House power and battery backup 315.5

Dwelling with fuel fired system and/or attached garage 315.2.1

104

WiFi Smoke detectors



Requires 120v at each device

Each device requires battery back up

WiFi needed to program, but not after that. The devices will signal each other.

105

Let's start roughing



106

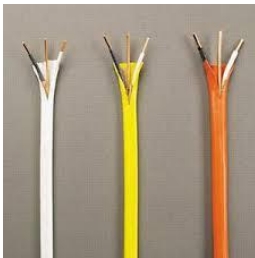


Bit and Brace



107

Color Blind



White	14 AWG	15a
Yellow	12 AWG	20a
Orange	10 AWG	30a
Black	read it	
Gray	UF, SE	

60 degree C rating T 310.15(B)(16)

108

I Joists Drilling and Notching



109



WOW, What a Knock-out



110

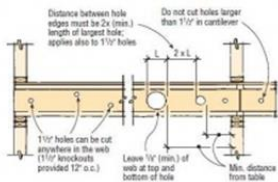
Multiple holes



111

Rules for wood I-joists

Hole-Cutting Rules for Wood I-joists



With wood I-joists and other types of engineered lumber, it's best to consult the manufacturer's literature. The example provided here is courtesy of Trus Joist MacMillan, ("Resipping With PEX," 10/99)

Min. Distance from Inside Face of Support to Near Edge of Hole

Depth	TJI/Pro	2"	3"	4"	5"	6"
9 1/2"	150	1'-0"	1'-6"	3'-0"	5'-0"	6'-6"
	250	1'-0"	2'-6"	4'-0"	5'-6"	7'-6"
11 1/2"	150	1'-0"	1'-0"	2'-0"	3'-0"	3'-0"
	250	1'-0"	1'-0"	2'-0"	3'-0"	4'-6"
14"	150	1'-0"	2'-0"	3'-0"	4'-6"	5'-6"
	350	1'-0"	1'-6"	3'-0"	4'-6"	6'-0"
16"	250	1'-0"	1'-0"	1'-0"	1'-0"	1'-6"
	350	1'-0"	1'-0"	1'-0"	1'-6"	3'-0"
18"	250	1'-0"	1'-0"	1'-0"	2'-6"	4'-0"
	350	1'-0"	1'-0"	1'-0"	1'-0"	1'-0"
20"	250	1'-0"	1'-0"	1'-0"	1'-0"	2'-0"
	350	1'-0"	1'-0"	1'-0"	1'-0"	1'-0"

General Notes:
 *Distance in the chart above is based on uniformly loaded joists using the nail main loads shown (in TJI's) brackets. For other load conditions or hole configurations, contact TJI's representative.
 **For single span (5-foot maximum) uniformly loaded joists, one maximum hole may be located at the center of the joist span provided no other holes occur in the span. DO NOT cut into joist flanges when cutting out web.

112



I-Joist Manufacturer Notes

NOTES:

1. Holes may be placed anywhere within the depth of the joist. A minimum 1/4" clear distance is required between the hole and the flanges.
2. Round holes up to 1-1/2" diameter may be placed anywhere in the web.
3. Perforated "knockouts" may be neglected when locating web holes.
4. Holes larger than 1-1/2" are not permitted in cantilevers without special engineering.
5. Multiple holes shall have a clear separation along the length of the joist of at least twice the length of the larger adjacent hole, or a minimum of 12" center-to-center, whichever is greater.

113

Multiple holes



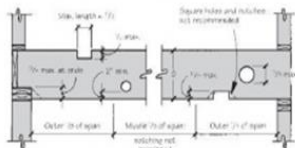
114

Solid wood framing

FRAMING GUIDELINES

Cutting, Notching, and Boring Lumber Joists

Joist Size	Maximum Hole	Maximum Notch Depth	Maximum End Notch
2x4	None	None	None
2x6	1 1/2"	7/8"	1 1/4"
2x8	2 1/8"	1 1/4"	1 1/4"
2x10	3"	1 1/2"	2 1/4"
2x12	3 3/4"	1 3/4"	2 3/4"



In joists, never cut holes closer than 2 inches to joist edges, nor make them larger than 1/2 the depth of the joist. Also, don't make notches in the middle third of a span, where the bending forces are greatest. They should also not be deeper than 1/3 the depth of the joist, or 1/4 the depth if the notch is at the end of the joist. Limit the length of notches to 1/3 of the joist's depth. Use actual, not nominal, dimensions. ("Field Guide to Common Framing Errors," 10/91)

115



Things that make you go...Hmmm



116

Electrical Rough Inspection



117

Not a Rough Inspection



118



Wiring Quiz

- Type NM Cable
 - 1) How far from edge of wood when cable runs along a stud or joist?
 - 2) How far from edge of wood to pass-through stud or joist to avoid using a nail plate?
 - 3) Thickness of the nail plate?
 - 4) How many cables under a blue insulated staple?
 - 5) Distance between supporting staples?
 - 6) First support /staple distance from box?

1) Stack it



300.4 D Parallel to framing

“supported so that the nearest outside surface of the cable or raceway is not less than 1 ¼” from the nearest edge of the framing member “

120

2), 3) Nail Plate



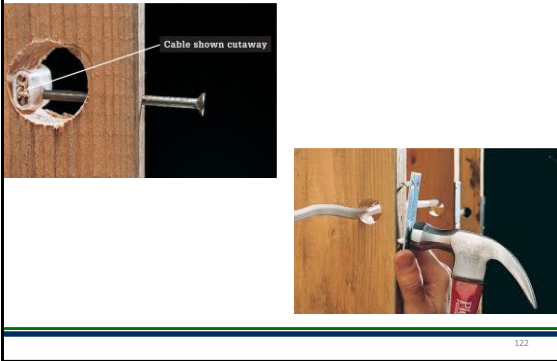
300.4 A 1 Protection

Edge of drilled *hole* is 1 ¼” or less – requires a nail plate – 1/16” thick - cover the width of the area

121



Boring subject



122

4) Staples

SN 40 IB
 1/2" Wide, 1" Long, Zinc Plated Low Carbon Steel, LDPE
 Blue Plastic Insulator



Armored Cable 14/2 And 14/3 Metal Clad 14/2 And 14/3
 Non-metallic Sheathed 14/2 Through 10/3 Underground Feeder 14/2 And 12/2

CATALOG NUMBER	ULC #	UNIT QUANTITY	MASTER CARTON	MASTER WEIGHT
SN 40 IB 100	78027	100	5000	51
SN 40 IB 250	75026	250	2500	26
SN 40 IB 500	75026	500	BUCKET	29



SN 150 IB
 1/2" Wide, 1-1/2" Long, Zinc Plated Low Carbon Steel,
 LDPE Red Plastic Insulator, Extra Long For Securing Up To Two
 Cables



One Cable Two Cables
 Non-metallic Sheathed 14/2 Through 10/3 Non-metallic Sheathed 14/2 Through 12/3
 Underground Feeder 14/2 And 12/2 Underground Feeder 14/2 And 12/2

CATALOG NUMBER	UPC #	UNIT QUANTITY	MASTER CARTON	MASTER WEIGHT
SN 150 IB 100	78027	100	5000	51
SN 150 IB 250	75026	250	2500	26
SN 150 IB 3M	75026	3000	BUCKET	29



123

SN 40 IB Staples



USE ON CABLE SIZES
 Armored Cable 14/2 And 14/3
 Metal Clad 14/2 And 14/3
 Non-metallic Sheathed 14/2 Through 10/3
 Underground Feeder 14/2 And 12/2

INSTALLATION INSTRUCTION
 Drive staple until contact with cable.

WARNING:
 This product must be used in accordance with all national, state and local electrical codes.
 Disconnect power.
 When driving staples, the size of safety glasses is recommended.
 Do not over drive staples as it may result in damage to cable insulation.

CUIDADO:
 Este producto debe ser usado bajo los códigos eléctricos nacionales y estatales.
 Desconecte la electricidad.
 Cuando se use las grapas, el uso de lentes protectoras es recomendado.
 No presione las grapas demasiado la inserción del cable puede ser dañada.

124



SN 150 Staples



125

5), 6) 314.17 C Exception



334.30 Support of NM cable

12" from every box
4 1/2' intervals along length

314.17 C exception

Single gang box with no clamps
(smash the knockout out), NM
cable 1/4" inside box, stapled 8"
from box.

126

Type of box for application



314.27 A (2)
Box listed to support weight:

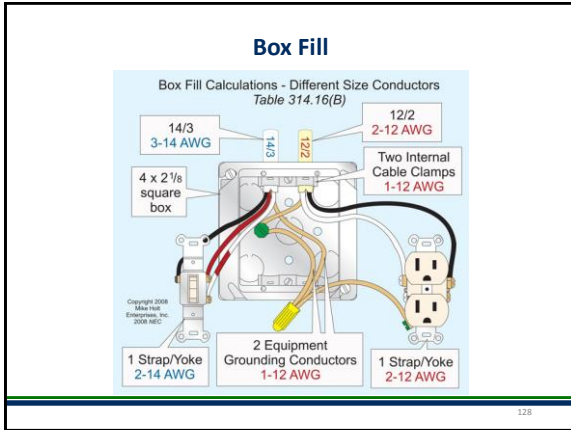
Fixture/ luminaire up to 50lbs

Paddle Fan (314.27 C)

Chandelier over 50lbs, listed,
support independently of box

Pendant

127

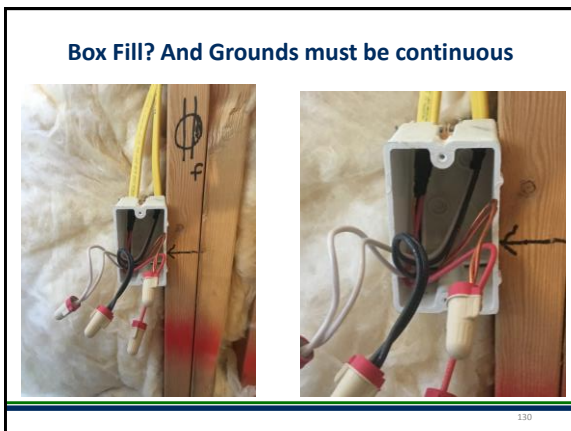


Box Fill Calculation

Volume allowance unit volume total

Volume allowance	unit volume	total
14 AWG 3 conductors	2.0	6
12 AWG 2 conductors	2.25	4.5
Grounds 1 12 awg	2.25	2.25
Clamps 1 12 awg	2.25	2.25
Device sw 2 14awg	2.0	4.0
Device rec 2 12 awg	2.25	4.5
		=23.5 cuin
4 x 4 x 2 1/8" sq box metal = 30.3 cuin (T314.16A)		
(plus the plaster ring)		OK
Don't count tails and wirenuts		

129



Box Fill Calculation

Yellow #12/2 and 12/3 Romex + 1 device

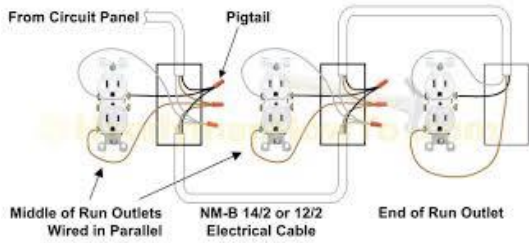
Conductors 5 x 2.25 = 11.25 (2 white, 2 black, 1 red)
Grounds = 1 x 2.25 = + 2.25
Device = 2 x 2.25 = + 4.5
min 18.0 cuin box

Don't count tails and wire nuts, no clamps

Minimum conductor into box 6"
Minimum conductor outside of box 3" 300.14
(length of a set of linesman pliers)

131

AFCI and GFCI device not wired like this



132

Final Inspection

133



Final Inspection



Proper labeling of Directory at Panel 408.4

Clearance in front and around Panel, light in panel area 110.26

Receptacle in area to be serviced 210.64

134

Rough or Final Inspection?



314.20 Flush Mounted

314.22 Surface Extension

What is the finish surface?

Noncombustible ¼" Tile, gypsum (sheetrock)

Combustible Flush Wood, fabric, wallpaper



135

Finished Surface

314.20 Installations within or behind a surface of concrete, tile, gypsum, plaster or other noncombustible material, SHALL BE MADE so that the front edge of the box will not be set back of the finished surface more than ¼".

Installation within a surface of wood or other combustible material, box shall extend to the finished surface.

314.21 Noncombustible surfaces that are broken OR incomplete around boxes employing a flush-type cover or faceplate SHALL BE REPAIRED so there will be no gaps or open spaces greater than 1/8" at the edge of the box.

136



Final Inspection



406.6 Faceplates seat against surface



139

Final Inspection



Test receptacles for proper operation and Polarity 200.10

Grounding Type 406.4 A

Secured 314.23
6-32 machine screw 406.5

Tamper Proof 406.12

GFCI, AFCI location 210.8, 210.12

Finish flush with surface 314.19, 314.20,
314.21, 406.5, 406.6

140

Outdoor Receptacle



Wet Location 406.9 B
(E4002.9)

15 and 20 amp 125v
receptacle to be **WR** type

Weatherproof enclosure
regardless if plug is inserted

Extra Duty type

GFCI protected

141



Final Inspection



Testing of Smoke Detectors/
CO detectors IRC R314/ R315

Interconnected R314.4

AFCI *is* required for bedroom
smoke circuits 210.12 A

Only a fire alarm system is exempt
from AFCI protection

AC/DC

142

Final Inspection



Service switches for fixed
appliances

Oil Burners and Furnaces
Gas Burners
AC Air handlers
AC Compressors
AC Split Systems
Water Heaters
Water pump

143

Final Inspection

144



STATE OF CONNECTICUT



MICHAEL OSE
 Construction Services Building Official
 DAS CONSTRUCTION SERVICES
 Office of the State Building Inspector

Tel: 860.713.5948
 Fax: 860.920.3083
 michael.ose@ct.gov

450 Columbus Boulevard, Suite 1303
 Hartford, CT 06103

147

Use of OEDM Training Materials

Use of Office of Education and Data Management (OEDM) training materials must be approved in writing by the State of Connecticut, Department of Administrative Services' Office of Communications. In approving of such use, the State of Connecticut assumes no liability associated with such use, including, but not limited to, the user's dissemination of any inaccurate information or interpretation in connection with its use of these training materials. Use of the training materials is at the sole risk of the user, and the State's approval of the use does not constitute an endorsement of the user or its intended use.

148

